POWER

Volume 50 New York, September 9, 1919 *Number* 11

Impressions of a layman after his first trip through a modern power plant

Coal and Wood Furnaces Under Stirling Boilers

Brief review of Willys-Overland boiler plants. The two furnace boilers are a feature. Estimates place the saving in coal for two 740-hp. boilers at $25,000 per year.

IN TOLEDO, the Willys-Overland Co. has developed into one of the largest automobile manufacturers in the country, the output of cars in 1917 reaching 175,000. A floor space of 109 acres gives an idea of the immensity of the plant. The forge shop has over 80 hammers ranging from 1500 to 5000 lb. and as usual all steam-driven. Other uses for steam are heating and drying and for driving air compressors, about 10,000 cu.ft. of air per minute at 100 lb. pressure being required in the various shops. Much of the electrical energy for light and power is purchased. Steam needs, however, have been met by installing boiler capacity in accordance with the growing demand. During the winter there is usually sufficient exhaust steam from the hammers and the air compressors to meet the heating and drying requirements, additional live steam being needed only in the coldest weather. As this exhaust steam is discharged into a long main of large diameter and considerable storage capacity, the back pressure is equalized and remains practically constant at 3 lb. gage. In the summer there is still need of exhaust steam for drying, and the balance is utilized in a mixed-pressure turbine driving through reduction gearing a 750-kw., 440-volt, 25-cycle generator. As the creek water used for condensing purposes is dirty and at high temperature in the summer months when the turbine is operated, the vacuum does not exceed 27 in., so that it has been found necessary to increase the back pressure to 4 or 5 lb. to get capacity, and live steam is used to meet any deficiency in the supply of exhaust steam to the turbine.

At the present writing there are three distinct boiler plants, No. 1 being the oldest and now held in reserve. It consists of three return-tubular boilers aggregating 325 hp. No. 2 boiler house has 1800 boiler horsepower in six units of the Heine type equipped with overfeed stokers. Coal is handled by a continuous bucket conveyor with worm feeds to each stoker, the hoppers having been enlarged to hold 10 tons each. Ashes are removed by a steam-jet vacuum conveyor. Closed heaters and direct-acting steam pumps take care of the feed water. The plant is equipped with damper regulators, steam flow meters, CO_2 recorders and a gas collector on each boiler so that an analysis of an average eight-hour sample may be made with an Orsat to check the recorders.

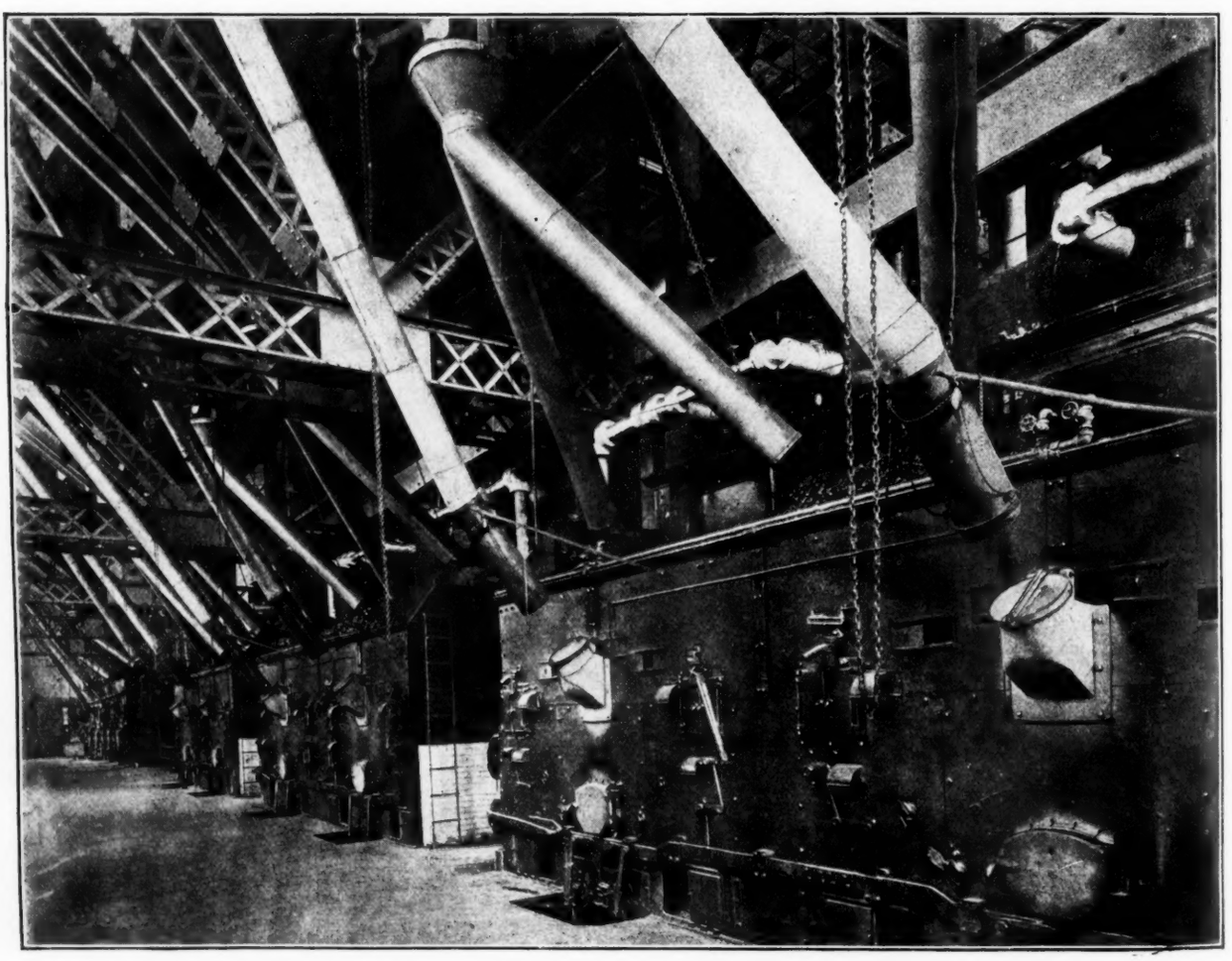


FIG. 1. THE TEN OLDER BOILERS IN THE WILLYS-OVERLAND STEAM-PLANT NO. 3

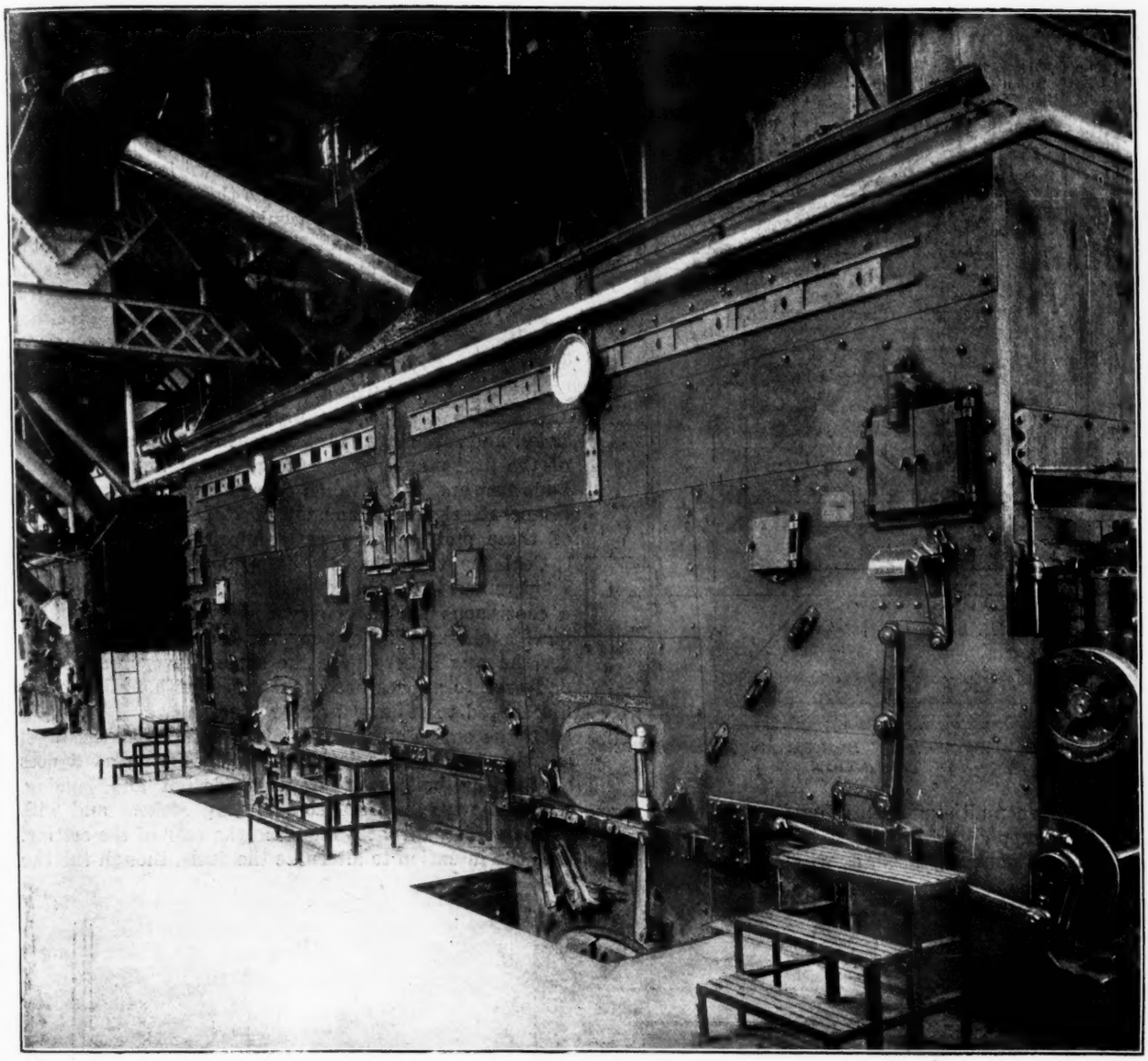


FIG. 2. NEW DOUBLE-FURNACE STIRLING BOILERS RECENTLY INSTALLED

Of the three plants No. 3 is the latest and largest. The aggregate capacity is 5300 boiler horsepower, consisting of six 300-hp. and four 500-hp. water-tube boilers served by V-type overfeed stokers and two 740-hp. Stirling boilers that have just been installed. To receive them the boiler house was extended and additions made to the coal and ash-handling equipment. In the older part of the plant the fuel during the day is largely shavings from the wood department. From a cyclone collection system provided with a "hog" to grind the larger pieces, the wood refuse is discharged directly into the furnaces through chutes entering at the front, there being no storage. The shavings are discharged on top of a coal fuel bed and by careful manipulation good combustion is maintained, the CO_2 averaging about 11 per cent. The furnaces are of the standard overfeed V-shaped type mounted as usual in a Dutch oven with a hole cut in the front face to admit the shavings. The records of the CO_2 recorders guide the firemen, and the analyses of the eight-hour samples from the gas collectors give the average CO_2 maintained on each boiler during each shift. Consequently there is a record of each fireman's work and at the end of each month the daily results are averaged and the figures posted for the benefit of the firemen. Working on a competitive basis they become interested in getting results and show active interest in maintaining economy.

The instruments now in use in the boiler room are practically the same as those in No. 2 plant and venturi meters for the feed water and coal scales have been purchased. There are damper regulators and air control for speed regulation of the stoker engines. The operating steam pressure is 160 lb. and the feed water is raised to 210 deg. in an open heater.

For the most part the feed water is returned from the heating and drying systems, and comes back to the boiler room at a temperature of 120 to 130 degrees. The makeup needed comes from the city mains. The water collects in a large receiving tank which has float control to admit makeup water directly from the city mains if necessary. From the receiver the water is delivered to an open heater under float control, which is at an elevation sufficient to give a 7-ft. head over the feed pump suction. A duplex direct-acting pump and a

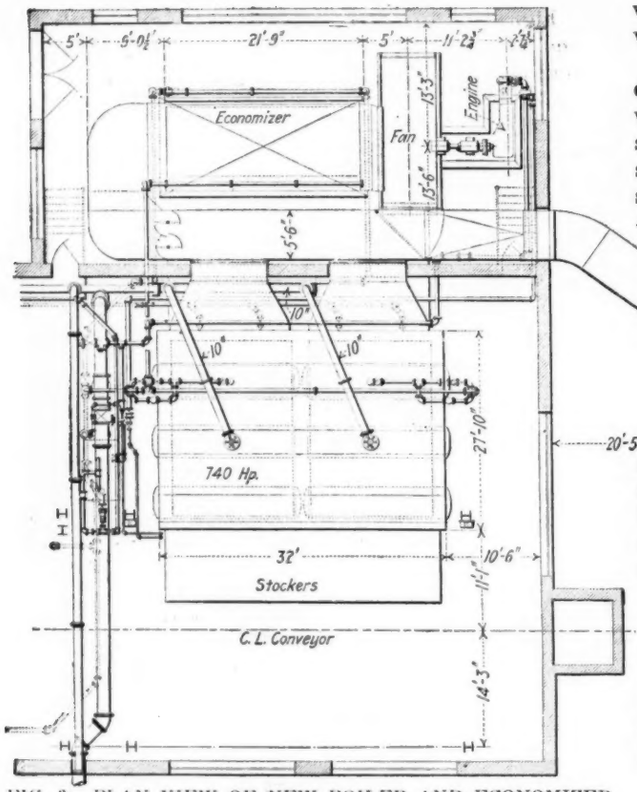


FIG. 3. PLAN VIEW OF NEW BOILER AND ECONOMIZER INSTALLATION

turbine-driven multistage centrifugal pump, each large enough to supply the ten older boilers under normal operation are generally used, as with the 7-ft. head and vapor pipes on the suctions they will handle the feed water at 210 deg. with no appreciable trouble.

In connection with the two new boilers one turbine-driven multistage centrifugal pump and an open heater with a separate V-notch meter and recorder were installed. Interconnection is made with the older system, so that the centrifugal may be thrown in on the general service. With a suction head on the new pump of about 4 ft., it was found that it would not handle water hotter than 150 deg. without becoming steam bound. Cold water jets to keep down the vapor were necessary, and these are located one in either leg of the V-casting forming the double suction entrance to the pump. The cold water is conducted through a ¼-in. pipe perforated with six ⅛-in. holes, and discharged into the casing against the vanes of the first stage, where the pressure would naturally be lowest and vapor would form more readily. With a comparatively small amount of cold water the service of these pumps was greatly improved.

Coal for this plant is dumped into railway track hoppers and is chuted down through rotary feeders into a continuous bucket conveyor delivering to individual steel bunkers. The system has been extended to care for the new boilers. By the same conveyor ashes are delivered to an overhead tank lined with firebrick and discharged to railway cars or trucks.

Of the entire steam generating equipment the latest addition is of particular interest, consisting as it does of Stirling boilers of standard design and baffling, equipped with overfeed coal-burning stokers and with wood-burning furnaces fed from the rear of the setting. It is the intention to alternate the fuels, though the two

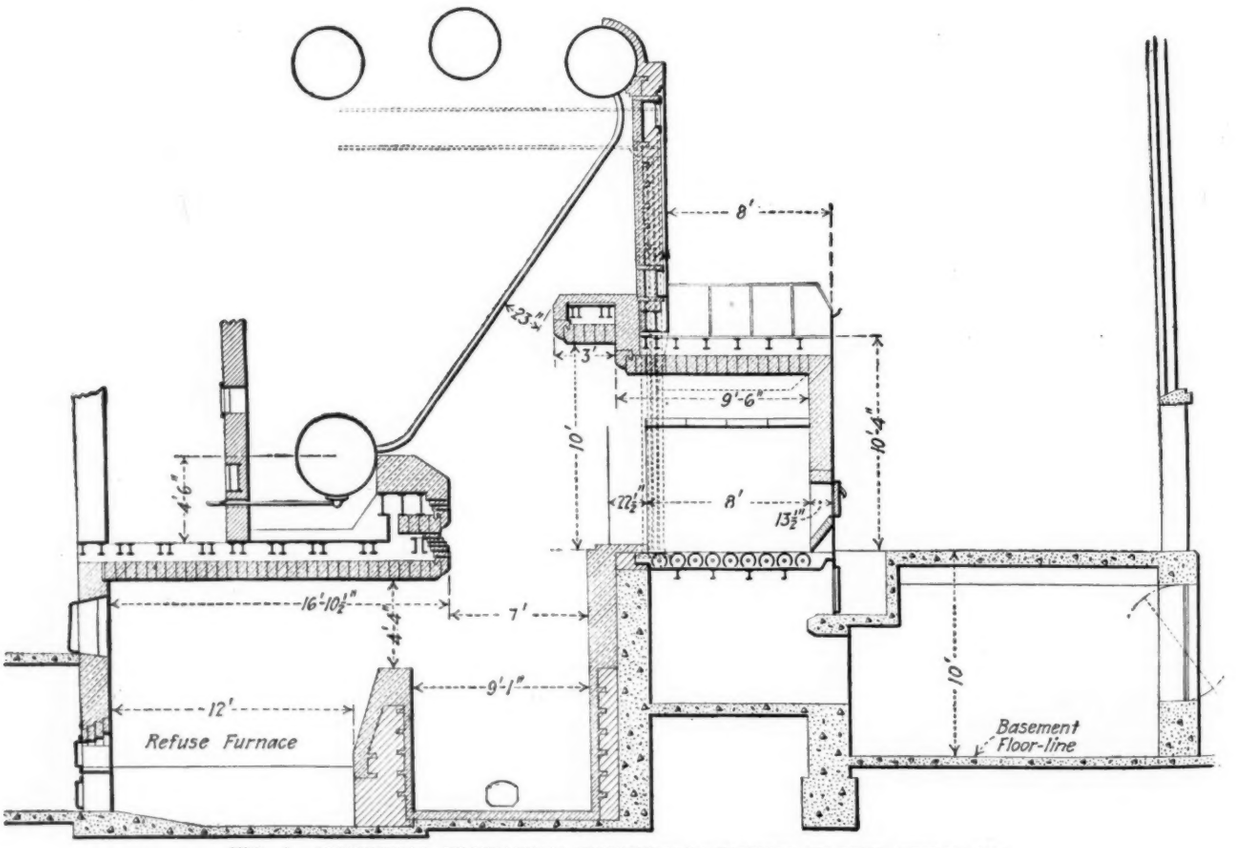


FIG. 4. SECTIONAL ELEVATION SHOWING LOCATION OF TWO FURNACES

perhaps may be burned simultaneously with some degree of success. Before the boilers were installed a great number of wooden boxes and pieces with nails and metal strips and all plant refuse had been burned on a vacant lot. The heat value in this wood and refuse will now be conserved and utilized to the fullest extent. It has been estimated roughly that the wood fuel reclaimed will save in coal $25,000 per year.

Fig. 3 is a plan of the new installation, and Fig. 4 a sectional view through the boiler setting showing the arrangement of the two furnaces. The wood-burning

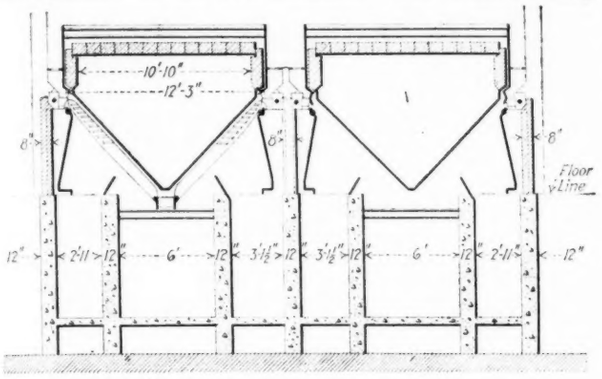


FIG. 5. SECTIONAL VIEW THROUGH OVERFEED STOKERS

furnace has been placed below the boiler so that the gases discharge behind the stoker into a combustion chamber common to the two furnaces. The long flame travel required by a wood fire is provided and, excluding the passageway at the rear of the stoker, a combustion chamber having approximately 19 cu.ft. of volume per square foot of grate. The latter is of the herringbone type, 12 ft. long and 11 ft. wide, giving a ratio to steam-making surface of 1 to 56. Operating experience has emphasized the difficulty of removing nails and steel bands which adhere closely to the grate. To relieve the situation a magnet has been designed that can be swung in over the grate to draw out these obstructions. Firing doors have been placed in the front and near the top of the furnace and below is a cleaning floor with doors above and below the grate. At a height 9 ft. 4 in. above the grates is a flat suspended arch having the unusual length of 16 ft. 10 in. and the furnace width of 11 feet.

The coal-burning furnace is equipped with a very large automatic stoker. A flat suspended arch instead of the sprung arch formerly used, makes a furnace width of 12 ft. 3 in. readily obtainable. The depth of the stoker is 8 ft., the projected area 98 sq.ft., and the active grate area 12.5 sq.ft., giving a ratio to steam-making surface of 1 to 61. In the combustion chamber the usual ventilated flat arch has been provided. Coal and ashes are handled as previously explained. From the wood furnace it is the plan to remove the ashes by means of a steam-jet vacuum system, although this equipment has not been installed.

On the average a little over 2 lb. of dry wood is equivalent to 1 lb. of the average quality of bituminous coal. As ordinarily dried in air the wood contains 25 per cent. moisture, and making deductions in proportion the heat value will approximate 6000 B.t.u. per pound. Due to the evaporation of this moisture and the likelihood of excess air, the combustion temperature is somewhat less than with coal, although in the present case the unusually large arch will help to maintain it at a high point. It is evident that with natural draft, if the two furnaces were operated simultaneously at rating, no advantage would be gained. The increase in the volume of the gas would cut down the draft and the mutual interference would no doubt result in an efficiency lower than would be obtained with either furnace alone. The plan, however, is to utilize the wood to an extent that the continuity of the supply will permit, the stoker serving as a standby to be brought in when necessary and operated at a rate sufficient to meet the demands on the boiler. With an induced draft fan of large proportions in connection with an economizer serving the two boilers, the above arguments may not hold. It will be interesting to see what the next few months bring forth.

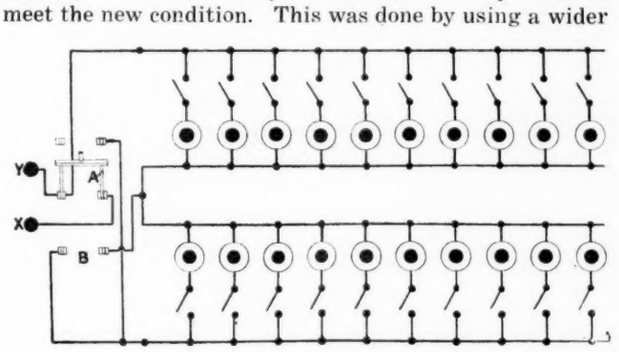
In the economizer there are 432 tubes 4¾ in. o.d. and 12 ft. long. The heating surface totals 7876 sq.ft. and for the passage of the gases there is an unobstructed free area of 52.33 sq.ft. As shown in Fig. 3, the economizer is placed to the rear of the smoke flue receiving the gases from the two new boilers. Passing in one direction the gases are drawn through the economizer by an induced draft steel-plate fan 12 ft. diameter and 6 ft. wide of the slow speed full housing type, and delivered back to the flue leading to the stack. It is driven by a 12 x 14-in. steam engine.

Engineers for the new work were Mills, Rhines, Bellman and Nordhoff, of Toledo, John Gillette of this firm having charge of the design and the installation work. For information concerning the plant we are indebted also to Orville Lindsey, chief engineer of heat and power, for the Willys-Overland Company.

A Simple 110- to 220-Volt Lamp Bank

BY R. A. PHILLIPS

In our plant we test our own watt-hour meters. While we had only 110-volt meters our lamp-bank load-box was a simple affair; but when the company complicated matters by giving us both 110- and 220-volt switchboard meters, it was necessary to rewire the lamp bank to meet the new condition. This was done by using a wider



SCHEMATIC DIAGRAM OF LAMP BANK

board for the base, and arranging the lamps in two rows instead of one, each row consisting of ten 110-volt lamps connected to a double-throw double-pole knife switch, as in the figure. With the switch in position *A*, both rows of lamps are in series, for use on 220-volt tests; while in position *B*, the two rows are in parallel for use on 110-volt tests. The lamp bank is connected to the circuit by the two binding posts, *X* and *Y*. Each lamp has in series a single-pole knife switch to obviate backing the lamps out in their sockets to regulate the load of the bank.

The Possibilities of New Fuel Mixtures for Internal-Combustion Engines

By E. HUMBOLDT

An article that deals with the production of a cheaper and cleaner substitute for gasoline by mixing with engine distillate a small amount of ether and alcohol. Economical methods for the production of alcohol and ether are described and the general use of such a mixture is predicted.

DURING the last few years there has been a tremendous increase in the manufacture and use of internal-combustion engines for motor cars, tractors, power boats, airplanes and all-around purposes generally, but the production of light fuels has not kept up with the demand.

The big oil producers have been steadily increasing the gravity of their motor fuel for the purpose of increasing the supply, but the quality has been correspondingly lowered and the proportion of low-boiling-point products has become too small for satisfactory results. This is to be observed more particularly with engines that are hard to start in cold weather. True, some engines run fairly well with heavier fuel, such as engine distillate, kerosene or mixtures of both, and most engines can run on them when they have become sufficiently hot. These heavy fuels have a somewhat higher thermal value than gasoline and under proper conditions could be capable of a higher efficiency. But the ordinary engine is not built to use them economically.

High Boiling Point and Imperfect Vaporization

When using any fuel the boiling point of which is too high, the vaporization is imperfect and a good deal of the liquid is entrained with the air through the intake manifold as a fine spray or, rather, a mist. The explosion is not satisfactory because there is no intimate mixing of the liquid and the air. The combustion is imperfect, and the exhaust carries away a good deal of intermediate gaseous products and of course a corresponding amount of heat units. Moreover, the liquid spray coming into contact with the hot walls of the cylinder always "cracks" more or less and leaves a hard deposit of carbon which adheres to the metal parts and must be forcibly scraped away.

Engine distillate has gone the same way as gasoline—up in price and down in quality, so that what was bought a few years ago for 5 or 6 cents a gallon, costs now 13 cents or more. Leaving aside the petroleum products, one finds that there are few liquids susceptible of being used as engine fuel in a practical way and at a resonable cost; the lower members of the aromatic series, such as mixtures of benzol and toluol, with a small amount of naphthalene and other impurities, have a high calorific power and are fairly volatile, as well as low in price. However, the visible supply of those products is limited.

Alcohol is also a good fuel and one that has the merit of burning cleanly. At the present time it is too expensive for ordinary use in this country and the supply is limited as well. Still, there is an abundance of materials capable of being used in its manufacture, and whenever our Government sees fit to remove a part of the red tape that fetters that industry, we shall most likely see industrial alcohol produced cheaply and in large quantities. There is no doubt that under proper conditions and by taking care of the byproducts of the fermentation, it could be manufactured at a cost well under 25c. per gallon in some of the large plants that were built for war purposes, but it is doubtful whether it will ever sell at such a low price under a heavy demand—at least not for some time to come; consequently, its use as an all-around fuel need not be given any immediate consideration, inasmuch as it can be used to best advantage only in engines specially built for that purpose.

Alcohol and Benzol Mixture

Although alcohol burns cleanly, leaving neither smoke nor coke, it has not so high a calorific power as benzol, and a mixture of both, in the right proportions, is better for all purposes if something else, like gasoline, is used for starting. When the engine is heated up, it generally runs very well on such a fuel. The Germans made good use of it during the war for airplane work, a separate tank containing gasoline being used for starting the engine. It was then cut out as soon as the machine had attained a speed at which it could use the higher fuel.

The relatively high prices of all those liquids and their troublesome use, as well as their scarcity at the present time, prevent them from coming into universal use, although in special cases they may prove to be just the right thing.

All kinds of "dopes" have from time to time been put on the market as carbon removers, boosters, etc., and all kinds of claims have been made regarding the performance of those compounds. Some were going to take the place of gasoline; others would nearly double the mileage and reduce enormously the cost of running a machine, and so on. And naturally, in spite of their slight cost, they have been put on the market at exorbitant prices. As carbon removers most of them are fairly good, although too costly, but their other qualities exist too often only in the dreams of their promoters, and this is probably the reason why most of them are not quite successful, commercially, and sooner of later die of oblivion.

Alcohol as a Carbon Remover

Alcohol, when mixed with either gasoline, engine distillate or benzol, makes a very efficient carbon remover, or rather a carbon preventive. One of its derivatives, ethyl oxide, or ether, is also a substance which gives a clean combustion and, moreover, possesses a very low boiling point, about 35 to 36 deg. C. for the commercial product, which is much lower than that of gasoline. It mixes in all proportions with alcohol and possesses the remarkable property of being soluble in the petroleum hydrocarbons and of increasing the solubility of alcohol in those same bodies.

Gasoline and distillate behave much the same in re-

gard to alcohol, ether and their mixtures; they dissolve about 5 per cent. of alcohol at ordinary temperature, while alcohol dissolves nearly 135 per cent. of gasoline. If both are mixed in such proportions that the alcohol be more than 5 per cent. of the gasoline and less than 135 per cent., the mixture will separate by standing in two separate bodies with a sharp surface of separation. One is alcohol saturated with gasoline, and the other just the opposite. Ether behaves in a different way. It dissolves slowly and produces a slightly turbid liquid which clears after a while. By using a mixture of ether and alcohol, the turbidity is more pronounced, and finally a small amount settles out of a liquid composed of alcohol, ether, water and gasoline. The amount separated varies with the proportion of the various components, the water content of the alcohol, and also with the temperature. In all cases the amount is small, and the separated liquid burns readily and completely, unless the alcohol used contained too much water.

Alcohol and Ether Mixtures

At the ordinary temperature a mixture of two-thirds ether and one-third alcohol dissolves about 3.06 parts of distillate, and one-half ether and one-half alcohol only 2.36 parts of distillate or gasoline. Whenever the proportion of hydrocarbon is above that amount, the solution is not complete at the ordinary temperature and the mixture is more or less milky, but settles very rapidly. Of course, if the ether is fairly well dehydrated and mixed with alcohol of not less than 95 per cent., or 190 proof, the liquid separated at the bottom does not contain very much water and burns readily; consequently, it does no harm whatever. Using alcohol of a lower proof simply results in more water separating and collecting at the bottom of the mixing or settling vessel, whence it can be drained out.

At the close of the war the company with which the writer is connected, like many other firms, found itself not only with a large plant for the manufacture of alcohol, which could not be run to full capacity, but also with a fairly good-sized stock on hand, which it was practically impossible to reduce or to dispose of immediately. Moreover, it had a large amount of molasses in storage and contracts for a good deal more for future deliveries. Of course molasses finds a ready market and a large outlet has been found in the manufacture of stock feeds; consequently, no anxiety need be felt on that account. Still as it was not convenient to close down the distillery, an outlet had to be found for the alcohol, and its use for fuel was one of the first that presented itself and the one that seemed to hold the best promise of success.

Distillate, Ether and Alcohol

Starting from the assumption that the price of distillate will remain comparatively low for some time to come, it seemed rational to take ordinary engine distillate, add to it the right proportion of a mixture of alcohol and ether and correct two of the main disadvantages attending the use of that hydrocarbon as an engine fuel, prevent the formation of carbon in the engine cylinders, and add a sufficient amount of low-boiling-point products to provide easy starting.

After some experiments on a small scale it was decided to try a compound of 8 parts of engine distillate, two-thirds of ether and one-third of alcohol in a six-cylinder automobile engine. The object was to find out how the fuel would act on the engine and how it would compare with ordinary gasoline for efficiency, ease of starting and sensitiveness to control. Several runs were made, varying from 50 to 200 miles and aggregating over 1000 miles, covering all kinds of road conditions, speed and loads.

Shortly after starting on this fuel the engine began to act queerly, sputtered, and finally stopped altogether; after a short stop the engine started easily but did not respond to control and soon stopped again. On taking out the carburetor, it was found to be plugged with scale and dirt.

Also the pipe connecting the vacuum and the supply tanks was plugged. The whole feed system was thoroughly cleaned and the tank filled up again. The engine ran for about one day in a satisfactory way, then began to act queerly again. Another good cleaning was given the fuel-feed system from one end to the other, and since that time it has given no trouble.

Of course the carburetor, feed pipe and supply tank had not been cleaned since the machine was first put into commission and the dirt which had accumulated during that time was covered over with a greasy film left by the gasoline itself. So long as nothing but gasoline was used in the machine, that sediment collected undisturbed, but the alcohol loosened it and allowed it to run with the liquid and collect where it would surely call attention to its presence.

The spark plugs were practically clean all the time, showing neither carbon nor corrosion but just a small amount of loose and light soot. The pistons and cylinder heads were originally covered with hard coke, but the last time those parts were examined they were absolutely clean.

A mixture of two-thirds ether and one-third alcohol compounded with from twenty-five to forty times its volume of gasoline, was tried on a motorcycle for several days in succession with the same results. The motor started easily—much more so than with gasoline alone—gathered up speed quickly and picked up the load without any trouble. The spark plugs and the cylinders, which were coated with carbon at the beginning, were cleaned and remained bright and smooth for the rest of the trial.

Results Obtained from Experiments

From these experiments we can conclude that the addition of alcohol to the ordinary petroleum fuels prevents them from forming any carbon deposit in the engine, and insures a thorough, clean combustion. The addition of ether insures a better solution of the alcohol in the hydrocarbon. It is also a carbon preventive, and secures the necessary product of low boiling point for easy starting. At the same time both ether and alcohol have a fuel value not to be despised.

It should be remarked that the solution of alcohol and ether in gasoline or distillate behaves at distillation like a good many other mixtures of liquids of different boiling points. A true separation can be obtained only after repeated, careful rectifications. This is a distinct advantage, because the ether in its evaporation entrains a large proportion of alcohol and hydrocarbons boiling at a higher point than ether alone, but much lower than either one of the others. Thus, a relatively small amount of ether generates a sufficient quantity of fairly low boiling product to insure a good, rich explosive mixture and easy running at a low temperature.

The next series of tests were made with benzol. Most of the experiments were made with a mixture of eight

parts of benzol and one part of one-third ether and two-thirds alcohol, although other proportions were tried also. An excess of ether, such as two-thirds ether and one-third alcohol in sufficient quantities to prevent coking, is not satisfactory. The engine starts very easily, but as soon as it begins to work hard, the rapid evaporation produces an enormous cooling of the carburetor, which I have seen several times covered with frost. The consequence is that it is unable to pick up the load and acts as if the feed pipes were obstructed. A jacket on the carburetor does not help matters either, unless there is a special provision for cutting down the amount of fuel.

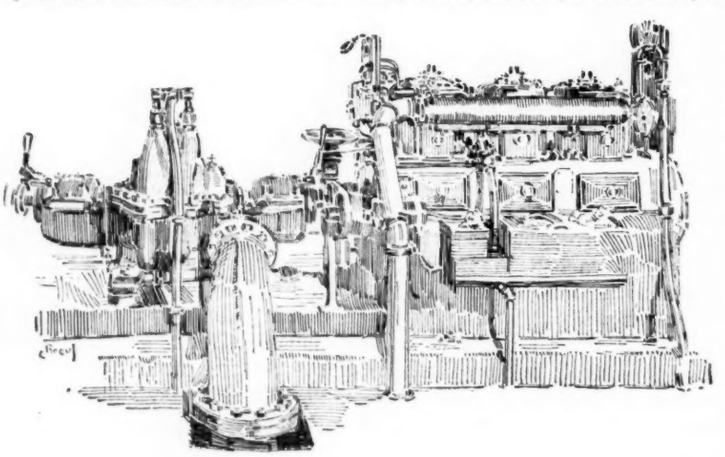
Carburetor Float Should Be Metal

It should also be remembered that benzol dissolves the shellac coating on the carburetor float, and the float should preferably be made of metal, or at least of a single piece of cork, and small enough to allow for a little swelling. Under these conditions, no trouble need be anticipated. The mixture of gasoline or distillate, ether and alcohol, as used in trial runs, has scarcely any effect on shellac.

As has been said before, the supply of benzol is limited, and relatively small. Unfortunately, it is not the habit of American manufacturers to save their byproducts, and material which might become very important is thrown away. It is to be hoped that the events of the last few years may teach them a much-needed lesson, and that in the very near future nothing will be wasted that may be put to good use. The production of benzol and alcohol can be greatly increased, and their conservation will surely prove a great boon when the supply of light petroleum begins to run low.

The manufacture of ether from alcohol is a simple matter, and to those who are accustomed to look upon ether as a rare and expensive chemical, the writer would say that it can be made for less than 10 per cent. over the cost of alcohol. There are, however, more recent and better processes for its manufacture which, by using alcohol in the vapor phase, produce very pure products with a better yield, and consequently much lower cost. The installation is simple and cheap, and the operation, which involves nothing but temperature control, is so simple that anyone of ordinary intellect can handle the apparatus.

Among those processes the two best ones only will be briefly described because they have proved their worth. The first one consists of superheating the alcohol vapor to the right temperature and then either forcing it through the dehydrating bath kept at the same temperature or rejecting it in a tower filled with resisting material, over which flows the acid, also preheated. The outgoing vapors, before condensing, are partly cooled through several heat exchanges in which the alcohol is vaporized and partly superheated. In this way the conversion of alcohol into ether is much more complete. There need be no overheating, no production of permanent gases and consequent waste of alcohol; and the amount of heat necessary for the conversion is less than 10 per cent. of that in the old Barbet or Williamson apparatus. The other process consists in passing alcohol vapors, previously superheated, over alumina acting as a catalyst, also heated at that same temperature. When the time of contact is sufficient, the conversion is easily 90 to 95 per cent. and if the right temperature has been accurately maintained there is no loss of alcohol and the vapors issuing from the converter are composed only of ether, water and a little alcohol. But if the temperature is allowed to rise to 290-300, ethylene is formed in increasing proportions, until at 300 to 400 deg. there is no ether left. The contact material must be in suitable shape so as to present as much surface as possible and not offer too much resistance to the passage of the vapors. The outgoing vapors are naturally at the same temperature as the converter, about 200 deg. C., and they are passed through a number of tubular heat exchanges, well insulated, when they give up the heat to the alcohol to be evaporated and to the alcohol vapor itself, so that the small superheater is all the necessary heating appliance.



Cost of the Mixture

As to cost, adding the mixture of ether alcohol to distillate, and taking ultraconservative figures of 45c. a gallon for alcohol and 60c. for ether, we would have:

8 gal. distillate at 13c.	$1.04
⅓ gal. alcohol at 45c.	0.15
⅓ gal. ether at 60c.	0.40
	$1.59

9 gal. mixture, 17⅔c. per gallon.

Remember that alcohol can be made for much less than 45c. and that a well-built plant of large capacity can produce it usually at a profit for 25c., bringing the cost of ether down to about 30 or 35c. maximum, and you will find it very easy to arrive at conclusions. Even when used as a "booster" and carbon remover, in the proportion of about 1 in 30 or 1 in 40 of gasoline, it is a paying investment.

These fuel mixtures are not to be compared with most of the carbon-removing compounds put on the market from time to time under fancy names and at high prices, some of which contain a little acetone and benzol, others benzol, naphthalene, picric acid, etc. They have a particular advantage that they render available for use in high-grade engines the less valuable petroleum products, and their manufacture can easily develop into a very important industry. Moreover, since there is little likelihood of the fuel supply exceeding the demand for a long time to come, there can hardly be any competition of the kind which is ruinous to manufacturers. On the contrary, with prohibition coming on it will open up a market for all the surplus alcohol already accumulated and utilize a large percentage of our present industrial waste.

Electric Speed Indicators

By VICTOR H. TODD

The principle of operation, constructional features, method of gearing and application of electric speed indicators are discussed.

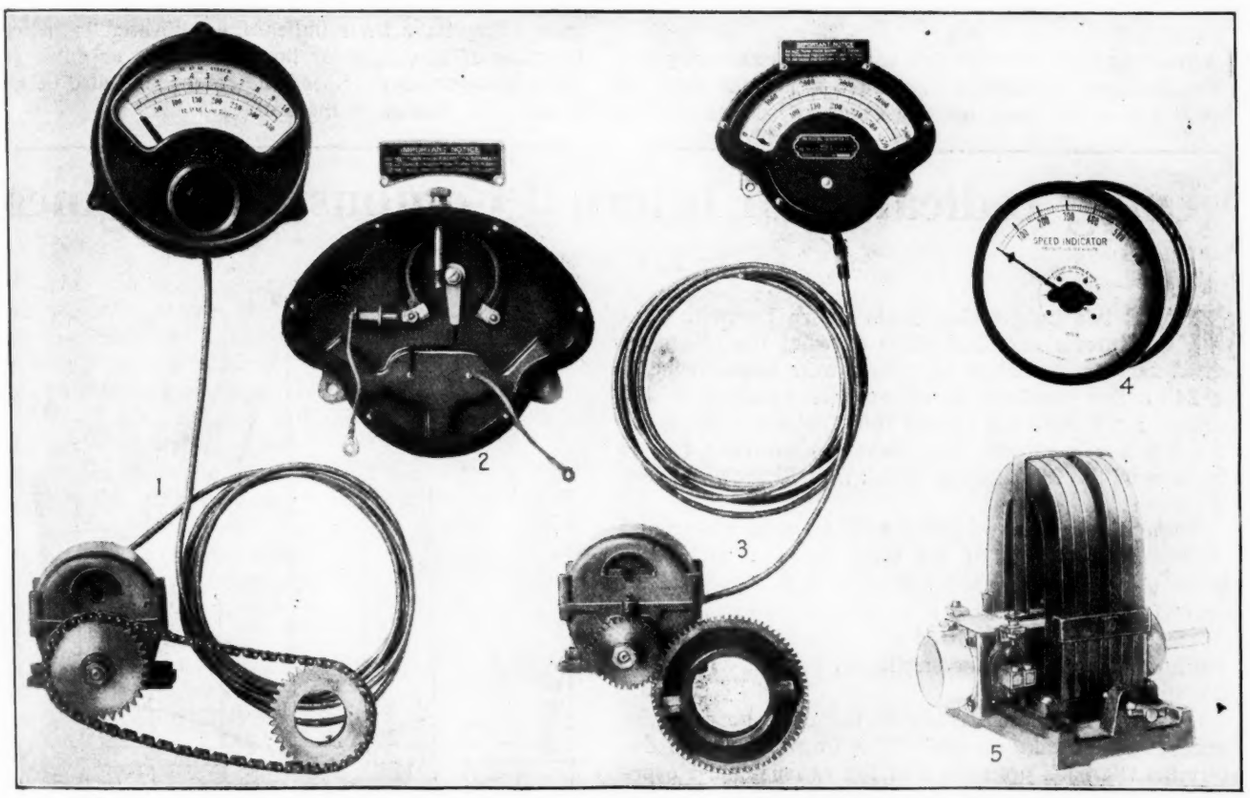
THE electric speed indicator consists essentially of two parts: a small direct-current magneto-generator, which is chain-driven or geared to some rotating shaft of which it is desired to know the speed, and a direct-current voltmeter or millivoltmeter, preferably of the permanent-magnet moving-coil type. The magneto generates a voltage directly proportional to its speed, and since the pointer deflection is proportional to the applied voltage, the scale on the indicator may be marked to indicate directly the speed of the shaft or any terms which are a function on this speed.

A typical outfit for an automatic stoker is shown in Fig. 1. The indicator is marked to indicate the revolutions per minute of the line shaft and the corresponding r.p.m. of the stoker shaft. The long flexible cable enables the indicator to be placed at any convenient point, for instance, over the engineer's desk, or in the manager's office. The magneto is provided with a sprocket wheel and chain; also a driving sprocket wheel, the latter to be fastened on the line shaft. The generator is very accurately constructed, using permanent magnets for the field poles. The commutator is made of 14 karat gold and the brushes of 18 karat gold to insure an accurate voltage over a long period of time. One bearing has no outlet while the other is provided with a watertight construction. Fig. 6 shows a graph of the voltage generated. It will be noted that the magneto generates a voltage directly proportional to the speed from 0 up to 1800 r.p.m. at which speed it generates about 950 millivolts. In Fig. 5 is another magneto which generates 20 volts at 1000 r.p.m. The meter with which this machine is used is shown in Fig. 4.

In calculating the speed indicator outfit, gears or sprockets should be selected to give a normal magneto speed. Of course, the magneto need not be run directly from a slow-moving or fast-moving shaft; it may be run from any suitable shaft the speed of which is proportional to that of the speed to be indicated.

For instance, on a gasoline engine, instead of gearing the magneto to the flywheel shaft running at 2000 or more r.p.m., it may be geared to the camshaft running at one-half the speed of the flywheel. If, however, a shaft of suitable speed is not available, it is necessary to provide suitable gearing. For instance, assume it is desired to indicate the speed of a steam engine running 250 r.p.m. If the speed of the magneto should be about 1000 r.p.m. it follows that a 4 to 1 gear or chain must be used, then, if the magneto's gear has 40 teeth, the gear on the engine shaft must have 40 $\times$ 4 or 160 teeth. If the meter reads full scale at 1000 r.p.m. of the magneto, the full-scale point may be marked 250 r.p.m., as this engine speed will produce full-scale deflection of the meter.

In some cases it is desirable to provide for over-



FIGS. 1 TO 5. SHOWS DIFFERENT TYPES OF ELECTRIC SPEED INDICATORS

speed. In this case, the speeds are figured as before, but the meter is adjusted to read only about three-

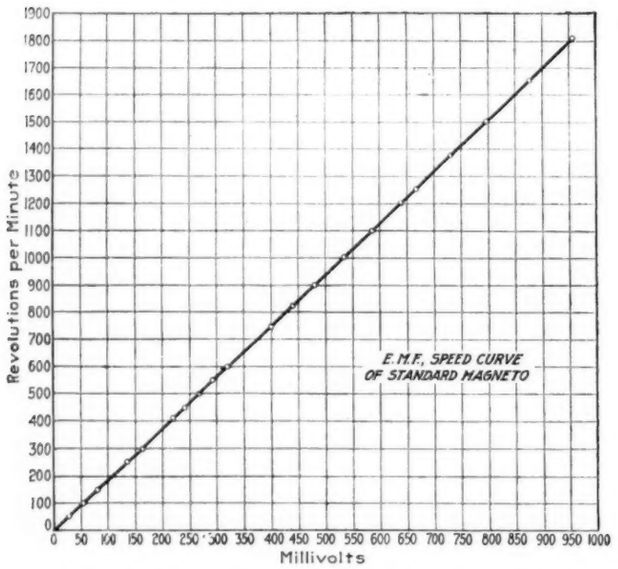


FIG. 6. VOLTAGE CURVE OF MAGNETO, FIG. 1

fourths or two-thirds of full scale at the normal point. For instance a machine may have a normal speed of 2000 r.p.m., but may have occasion to run as fast as 3000 r.p.m. at times. The sprockets or gears would be selected with a 1 to 2 ratio to give 1000 r.p.m. of the magneto at normal speed. At 3000 r.p.m. the magneto would make 1500 r.p.m., consequently the meter would be adjusted to give full-scale deflection on 1500 r.p.m., but this point would be marked 3000 r.p.m. and the other points proportionally.

Fig. 3 shows an important application of an electric speed indicator. This meter indicates the speed of the stoker's line shaft and also the "pounds of coal per hour" which is burned under the boiler. As stated before, this meter may be installed where the engineer can tell at a glance just how fast the coal is being consumed. The meter in Fig. 1 is a similar application but indicates the r.p.m. of the stoker shaft. The rear view of the indicator, Fig. 3, is shown in Fig. 2. This discloses a small circular-shaped rheostat which may be operated by the little thumb nut on top of the meter. In case of a slight discrepancy between the speed of the shaft and its indication on the meter, the rheostat may be shifted until the two correspond.

Other applications are on air compressors; or fans to indicate their speed and also the air delivery per hour, so that the quantity of air necessary for complete combustion of coal may be accurately known. Water pumps may have their indicators calibrated to indicate the rate of discharge or flow in gallons or cubic feet per minute or hour. Speed indicators may also be used in place of frequency meters.

Using Indicator on Internal Combustion Engines

BY RALPH MILLER

THE two light-spring cards shown herewith offer an interesting illustration of what the oil-engine diagram can show us. Both were taken from 23 x 24-in. four-stroke-cycle oil engines running at 150 r.p.m. No. 1 engine is located 7000 feet above sea level; No. 2 is near sea level. The elevation, however, has no bearing on the comparisons which we will draw between the cards.

These diagrams were taken with an 8-lb. spring and show only that part of the total diagram which lies below the atmospheric line and 10 to 11 lb. above it. In order to take such a card it is necessary to use a stop. A piece of brass tube fitted over the indicator piston rod and cut to a suitable length will prevent damage to the spring.

Only two complete strokes of the cycle appear—the exhaust and intake strokes. The former helps to determine the back pressure that the exhaust must overcome. This should, of course, be kept as low as possible, and with well-designed exhaust piping utilizing the kinetic energy of the exhaust gas column it is possible to lower the back pressure almost to the atmospheric pressure. Referring to diagram No. 1; the exhaust line indicates a too long and obstructed exhaust pipe. Investigation showed this to be true. Diagram No. 2 had a much shorter exhaust pipe with few elbows, and the card plainly shows the advantage.

The line representing the intake stroke falls, of course, below the atmospheric line and shows at a glance whether the air passages are free. In large, moderate-speed engines the suction pressure should not go lower than 2 lb. below atmospheric.

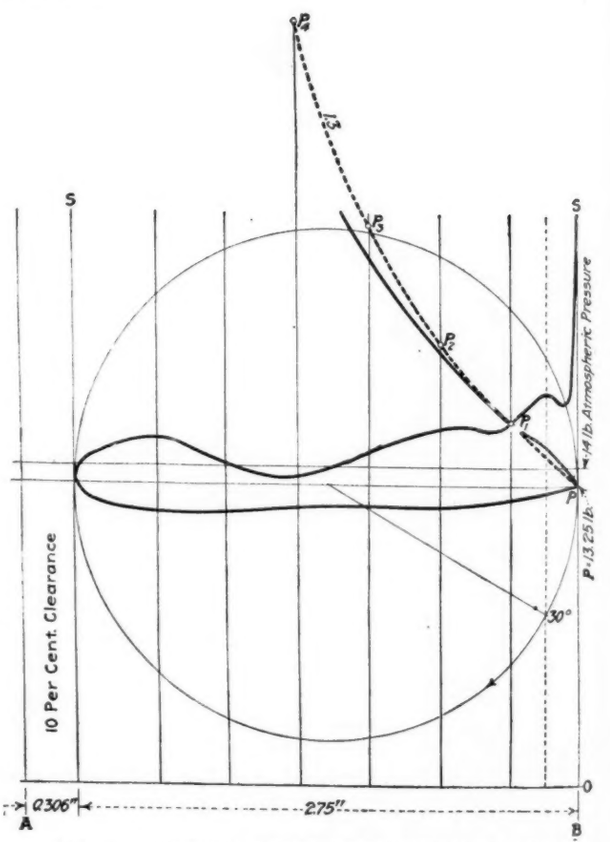


FIG. 1. SHOWING OBSTRUCTED EXHAUST AND LOST COMPRESSION

The next line on the card representing the compression stroke, is found to be the most interesting and useful; however, in order to read the compression line the theoretical adiabatic compression curve must first be laid out. The engine in question has a compression of about 290 lb. absolute. The clearance space, therefore, is about 10 per cent. of the cylinder volume. Proceeding to lay out a theoretical compression curve P_1 P_2 P_3 P_4 add the clearance to the diagram in the same scale as the length of this represents the piston displacement. Divide the total length A B into an equal number of parts, say eight, and raise perpendiculars

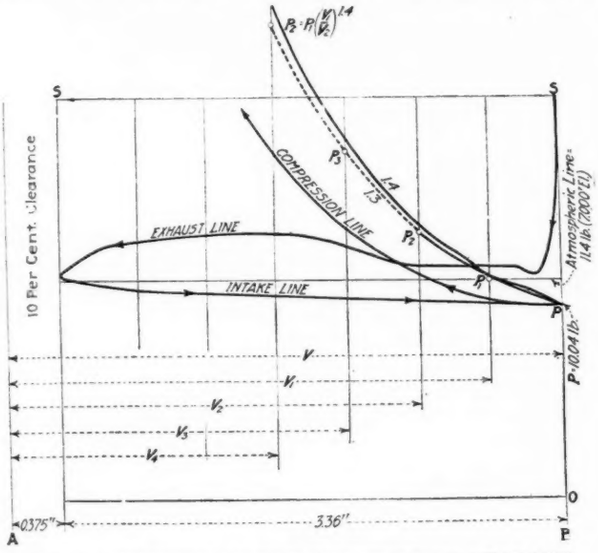


FIG. 2. SHOWING LITTLE COMPRESSION LEAKAGE

1, 2, 3, 4, 5, 6 and 7, as on diagram No. 1. Mark the atmospheric line with the barometric pressure at the time the card was taken in pounds per square inch. Draw in the zero line. If the atmospheric pressure were 14 lb. and an 8-lb. spring had been used, the zero line would lie $1\frac{3}{4}$ in. below this. Now measure the pressure at the beginning of the compression stroke. For instance, if the compression line touches the perpendicular S-B $\frac{1}{8}$ in. below the atmospheric line, the initial compression pressure will be 1 lb. less than the atmospheric. This pressure we will call P, or the initial pressure of compression in absolute pressure. To find point P in perpendicular 1, use the formula $P_1 = P \times \frac{V^n}{V_1{}^n}$

For instance, on card No. 2 $P = 13.25$, $V = 8$, $V_1 = 7$ and we have $P_1 = 13.25 \times \frac{8^{1.3}}{7^{1.3}} = 13.25 \times 1.19 = 15.8$ lb. absolute. Having used an 8-lb. spring point, P_1 is $15.8 \div 8 = 1.97$ in. above the zero line. In the same way find points P_2 P_3 P_4 by substituting $6^{1.3}$, $5^{1.3}$ and $4^{1.3}$ respectively in the formula and draw the curve through these points.

The exponent n in this case is taken as 1.3. It may vary in value between 1.25 and 1.45. However, for the purpose of checking up the condition of an engine by making comparisons between cards taken from time to time, it is of course advisable to always use the same exponent, and 1.3 will give a curve — lying close to the actual. High jacket-wall temperatures or a hot engine tends to increase the value of n, while leakage, such as loose fitting pistons or leaky valves, lowers its apparent value.

It will be seen at a glance that the engine from which diagram No. 1 was taken was losing compression. It is not quite plain, however, why the beginning of the compression line makes a loop with the intake line. Probably some of the readers can explain this phenomenon.

Diagram No. 2 shows very little compression leakage. Valves and pistons are in good condition. It will be seen that the presssure at the beginning of the stroke rises above the theoretical curve. This is due to the kinetic energy of the incoming air. During the suction stroke the air column in the suction pipe acquires a high velocity, which causes it to rush into the cylinder some time after the piston has started on the compression stroke. For this reason the suction valve is not closed on dead-center, but between 25 and 35 deg. after.

Improper Setting of Valves Caused Alternator to Hunt

BY ARTHUR HEARVEY

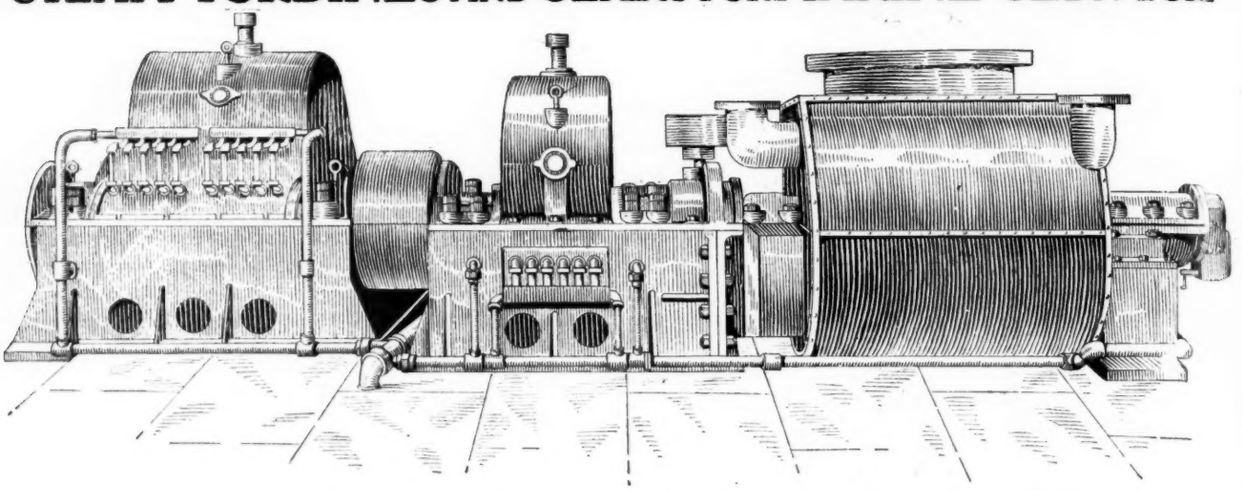
In a large paper mill where telautographs are being operated by current supplied by an exciter, direct-connected to a synchronous motor, trouble with illegible writing was experienced after three months' satisfactory service. The mill machinery was driven by 440-volt induction motors, the current being generated by two direct-connected alternators. A synchronous motor was used to correct the power factor and drive a direct-current generator in addition to its exciter.

The electrical engineer who was called in to locate the trouble observed that the armature of the synchronous motor was swinging back and forth in its bearing in step with the engine that was driving the alternator which was in use at the time, and that the hum of the motor fields also changed its note in time with the stroke of the engine. A voltmeter connected across the brush-holders of the exciter showed a slight variation in the voltage; this change of about one volt was causing the trouble in the telautograph.

The second alternator was put on the board and the first one disconnected. As soon as this change was made, all trouble stopped and the motor current dropped from 40 to 10 amperes. It was evident that the motor, working perfectly on one alternator, was not at fault. An examination of the first alternator showed it to be in first-class condition. The blame was therefore put upon the engine.

The log showed that the engine had been overhauled and the valves reset when the steam pressure was at 80 lb. with a load of 50 amperes on the alternator. The working pressure and load were 120 lb. and 200 amperes, respectively. The engine was indicated at full load and found to be taking steam for two-thirds stroke on the head end and about one-sixth stroke on the crank end. Engineers who have set the valves on high-speed four-valve engines know that they must be set for the average load at correct pressure, as the distribution of steam changes with the load. After resetting the valves, the motor and alternator operated without any further indications of trouble. This was unquestionably a case of hunting between the synchronous motor and the alternator due to a variation of the latter's angular velocity. The conditions causing hunting between two alternators are similar to those between an alternator and a synchronous motor, and the former are much easier to prevent.

STEAM TURBINES AND GEARS FOR MARINE SERVICE*



Showing the advantages of turbine drive with reduction gear for ship propulsion, some of which are greater speed for a given weight of power plant, less operating expense, greater reliability, saving in fuel and greater efficiencies.

THE advantages of the steam turbine over the reciprocating engine for ship propulsion, may be summarized in the main as: greater speed from a given weight of power plant, greater steaming radius or greater speed from the same weight of fuel or cargo carrying capacity with the same speed or steaming radius; also lessened expense for attendance and supplies, and increased reliability, as shown by less time lost in over-hauling and repairs. These advantages of the steam turbine appear in maximum degree when the geared steam turbine, rather than the direct-drive turbine, is compared with the reciprocating engine.

The best speed for a steam turbine, in the interests of efficiency and simplicity, lies somewhere between 1500 r.p.m. for a turbine of 20,000 hp., and up to 5000 or 6000 r.p.m. for comparatively small powers. The best speeds for propellers, especially for cargo vessels, are in the neighborhood of 100 r.p.m. Attempts to design an efficient high-speed propeller have been practically abandoned.

For very large powers the steam turbine running at slow speed can be used with less loss than for moderate or small powers, but even so, speed-reducing gears give better economy as compared with direct drive, due to the more favorable speeds at which both turbine and propeller can be operated.

Turbine-Drive Efficiency

The saving in fuel of the geared turbine over the direct-drive turbine follows from the greater efficiency of the propeller when operated at slow speed and of the turbine when operated at high speed. In the largest vessels, where conditions are most favorable to the direct-drive turbine, the saving made by the geared turbine is 10 to 15 per cent. In small vessels the difference is greater, as small steam turbines running at slow speeds lose excessively through leakage.

*From data supplied by Geo. H. Gibson.

As compared with the reciprocating engine, the geared steam turbine is able to offer much better overall plant efficiency, due principally to the fact that it can utilize to advantage the highest superheat and vacuum.

The steam turbine is satisfactory and reliable when using steam superheated to any degree likely to be introduced in marine practice. The steam consumption of the turbine is improved approximately 1 per cent. by each 12½ deg. F. of superheat. The ability of the steam turbine to utilize high vacuums, as compared with the reciprocating engine, is remarkable. Little benefit is gained by reciprocating engines from increase of vacuum above 26 in., as the low-pressure cylinders and the valve ports are not able to handle the steam at the enormously increased volume. Steam turbines, on the other hand, show an increase in economy from higher vacuum nearly equal to the increased amount of heat available from the increased temperature range, or at least 8 per cent. between 28 and 29 in. vacuum referred to a 30-in. barometer.

The greater temperature range from higher steam pressure, higher superheat and higher vacuum is decisively in favor of the steam turbine as compared with the reciprocating engine. The steam turbine does not suffer a rapid decrease in efficiency, as does the reciprocating unit, from leakage past valves and piston rings, but maintains a good steam economy indefinitely. A gain in fuel economy of approximately 25 per cent. can be made through the installation of geared turbines, over that possible with the ordinary marine-reciprocating engine of the same capacity.

Saving in Space

The saving in space through the use of geared turbines will be self-evident from a few examples.

The turbine and gear shown in Fig. 1, supplies 1500 shaft horsepower, but occupies a space only 21 ft. 2¾ in. long, 9 ft. 2⅞ in. wide and 7 ft. 10 in. high, that is 1328 cu.ft., or 1.13 hp. per cu.ft. A geared turbine unit of 3000 hp. is only about 1½ ft. longer, 2 ft. wider, and about 1⅜ ft. less in height, occupying altogether about 1530 cu.ft., or 1.96 hp. per cu.ft. It weighs approximately 110,000 pounds.

An analysis of a number of reciprocating engine installations indicates that their weight is 50 to 100 per cent. greater than that of geared turbines. A com-

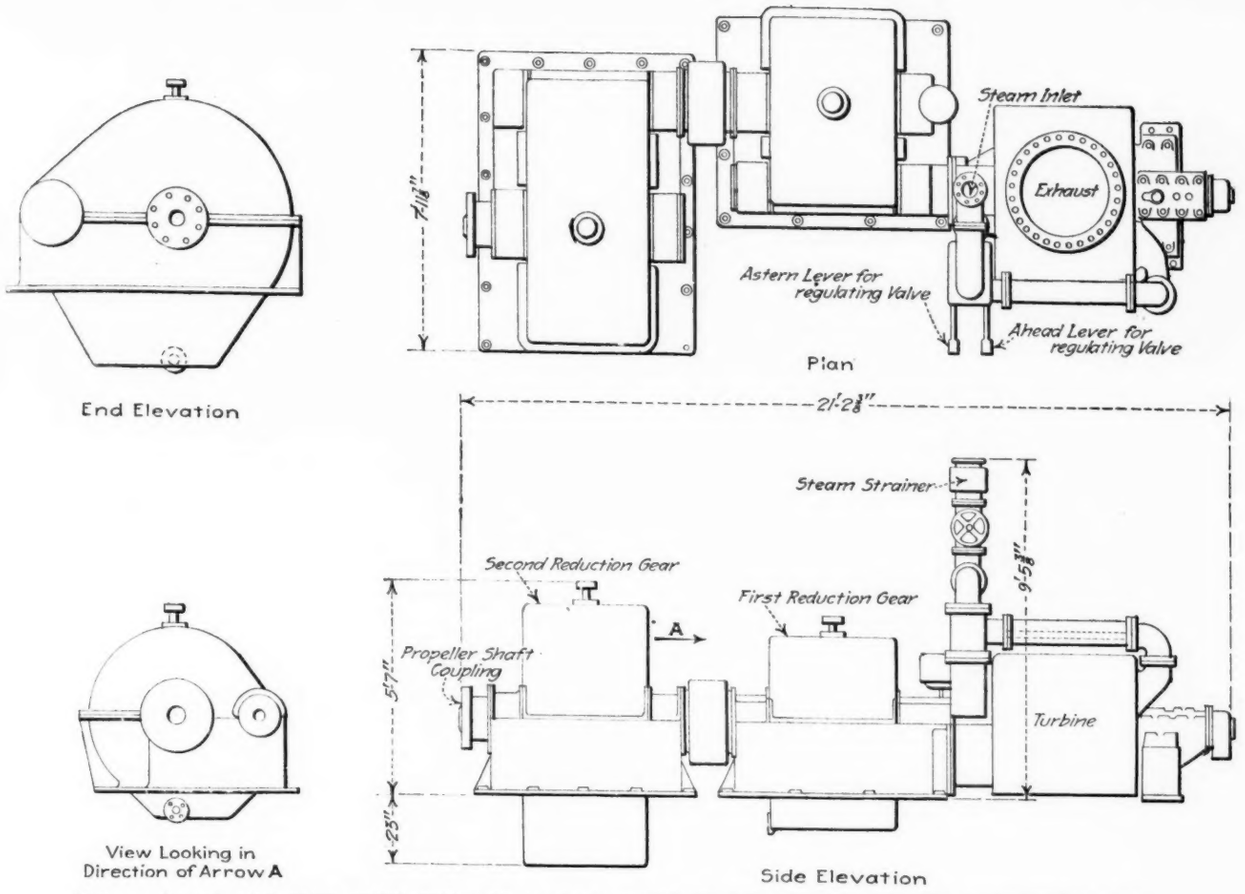


FIG. 2. PLAN AND SIDE ELEVATION OF MARINE TURBINE WITH SINGLE-PINION REDUCTION GEAR

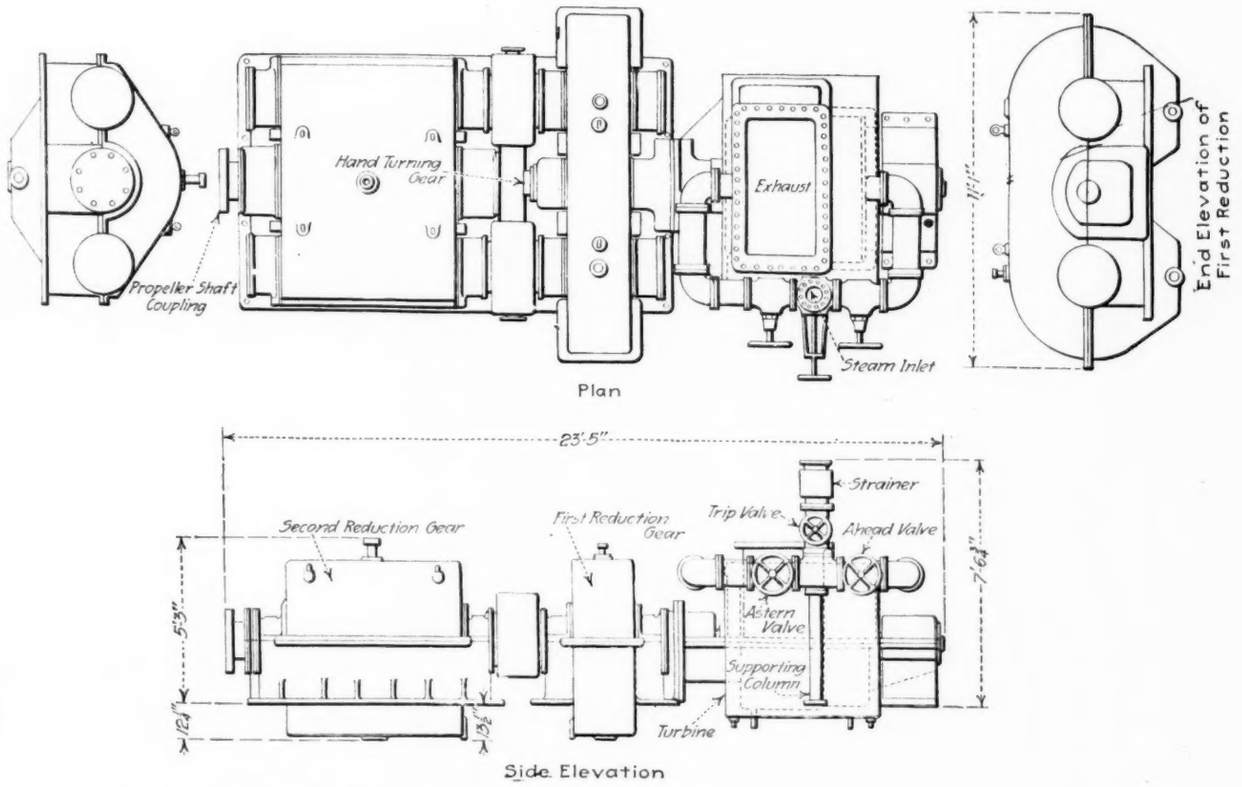


FIG. 3. PLAN AND ELEVATION OF A 3000-HP. UNIT WITH DOUBLE-PINION REDUCTION GEAR

parison of the cubical space requirements indicates approximately the same relative difference. For example the standard type 2500-hp. triple-expansion marine engine running at 90 r.p.m. weighs about 250,000 lb. and occupies a space of 20 ft. by 11 ft. 9 in. in plan and 21 ft. 3 in. above the floor level, or 5000 cu.ft., that is only ½ hp. per cu.ft. In larger powers the compactness of the geared turbine is still more apparent.

The arrangement of turbines and gears depends in any instance primarily upon the power and speed of the ship. For ratios up to 1 to 24, a single reduction may be used. There may be either one or two pinions. With two pinions the turbine is divided into high- and low-pressure sections, both, however, arranged to receive high-pressure steam, if necessary. Where a greater ratio of speed reduction is required, as on cargo ships, a double reduction is used. For small power, both high- and slow-speed gears may be of the single-pinion type as shown in Fig. 2, but for larger power and slow speed vessels the arrangement is generally as in Fig. 3.

Fig. 4 gives general dimensions of a 2500 hp. unit having independent high- and low-pressure turbines driving the propeller through a two-pinion single-gear reduction. This type of unit, while more expensive than the single turbine drive, is more efficient. The unit is so arranged that either high- or low-pressure turbines can be operated on high-pressure steam and exhaust to the condenser. Either turbine can be disconnected in case of accident, and the speed of the vessel can be maintained within approximately 30 per cent. of normal with only one turbine in operation which is not possible with the single turbine drive.

Three-Pole Switch on Compound D. C. Generator

By R. A. Phillips

When the series-field winding of a compound-wound generator is not energized, it is more guesswork than certainty to closely adjust the generator's voltage with that of the bus prior to paralleling. This is one of the disadvantages of having a three-pole switch on a compound generator—the series field is not energized until after the machine has been connected to the bus, and owing to poor voltage adjustment the machine may immediately take too much load. Another disadvantage of the three-pole switch was discovered one morning when we tried to parallel our second generator.

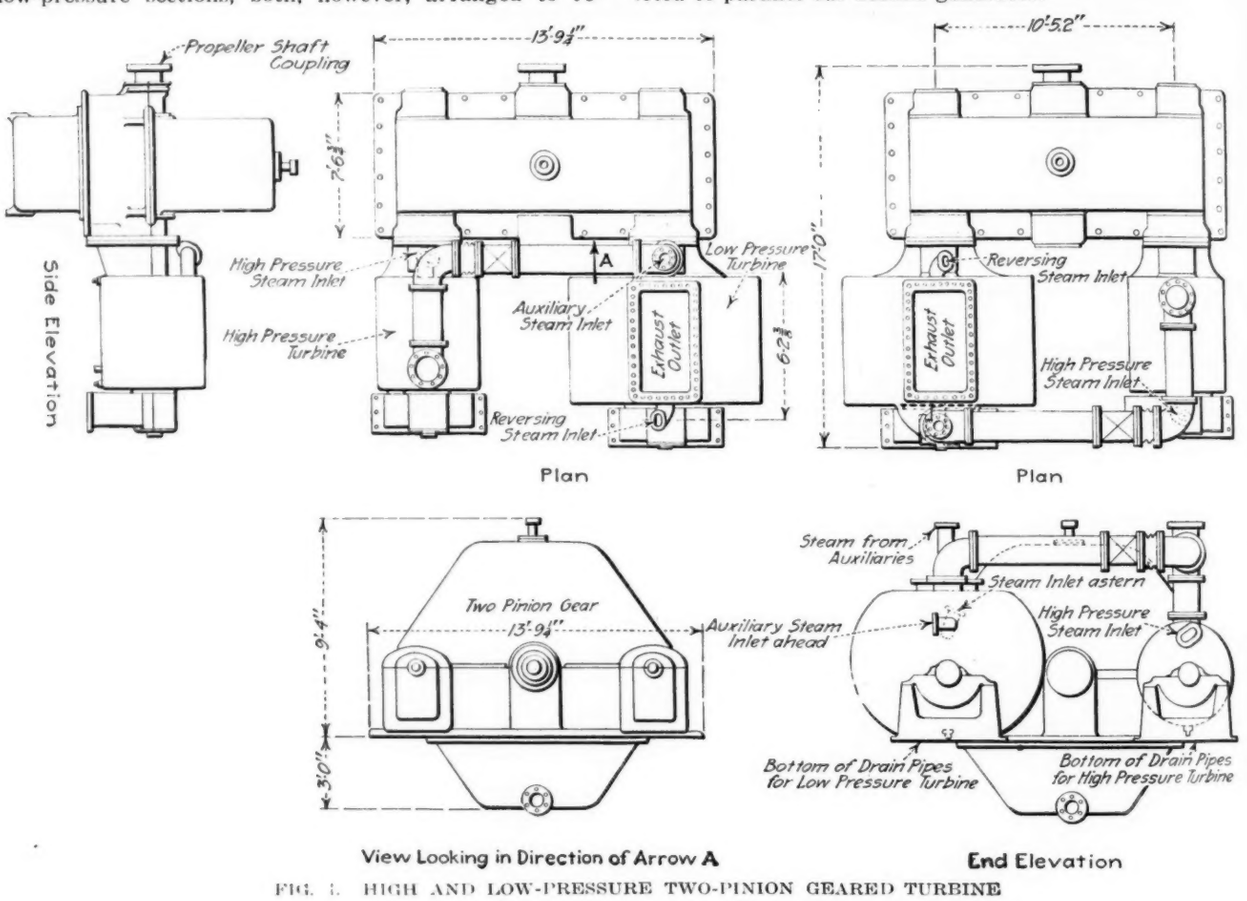
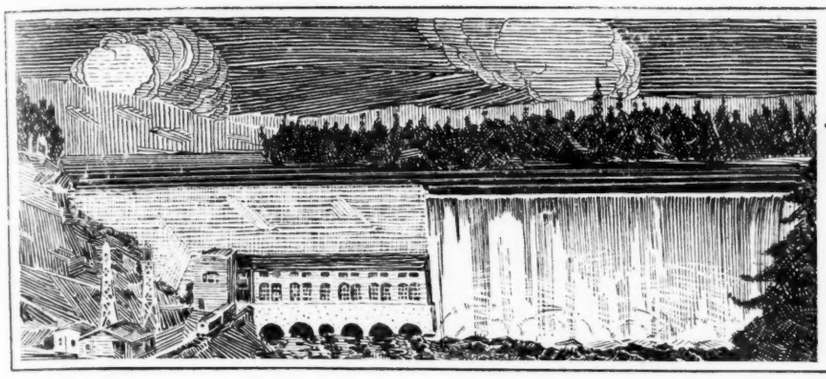


FIG. 4. HIGH AND LOW-PRESSURE TWO-PINION GEARED TURBINE

This machine is the oldest in the plant and is equipped with a three-pole switch. The other machines have three single-pole switches. Every time we closed the machine on the bus, it tripped its circuit-breaker and the breaker on the running unit as well. The third machine was started up, and the first time it was put on the bus the breakers tripped. When the operator opened the negative switch on the third machine, there was no flash, showing that the series fields of the two machines were not in parallel, which indicated at once what the trouble was. The oiler had forgotten to close the equalizer switch of the running machine. Had three separate switches been used on the second machine, we would have discovered this condition at once and saved needless interruptions. It might be added that there are cases where paralleling compound generators with three-pole switches caused considerable variation in the voltage at the time of paralleling.



POP'S WATER-POWER COURSE

By

John S. Carpenter

POP affected a sanctimonious look as he drew with bold strokes on a sheet of paper, while Jimmy moved up close to watch the thing take shape. When he stopped, he had the sketch shown in Fig. 1.

"Jimmy, see them gates I drawed in? S'pose I has to keep the runner a certain diameter an' I wanna make that gate casin' so that I can use two different runners in it, makin' no other changes except increasin' the height if I have to, one runner bein' 100 hp. an' the other 200 hp., how can I turn the trick?"

Jimmy thought a while before he replied: "The only way I can see is that you'd have to open the gates more as you increased the power."

"Yep, I can see that my work ain't been for nothin'. That's it, I gotta open them gates more, an' that's why most high-speed runners has pretty steep angles; the gates has to be opened 'way up to get the water through them. Now, take another look; here is them same gates opened, in one case 30 deg. an' in the other 45 deg. When we come to the problem of buildin' high-speed runners, we jes' take a gate casin' like this an' opens up the gates—the theoretical limit bein' when the gates is plumb radial, supposin' that they don't strike the runner blades or vanes before they are so far open. So much for that.

"A gate casin' may be used with a good many different runners, but each runner must be made to fit the angles of the gate casin' it goes with, the idee bein' that the entrance angles of the runner must conform not only to the angles an' openin' of the gate casin', but also to the speed and power of the runner itself. All of which is the same as sayin' that if you have a given size runner an' you wanna make it run faster than some other that you have in mind, you gotta change the entrance angles so they are shockless at three-quarter load, the load at which most turbines is figgered to have the best efficiency.

"In Fig. 2 you see three runners designed to be used with the same gate casin', but one is made for low speed, low capacity, the next for medium speed, medium capacity, an' the last for high speed, high capacity. As the speed goes up, the angle increases, the present-day angle bein' about 145 deg. The theoretical limit has been guessed at, but nobody knows, 'cause no manufacturer is gonna test a runner that he is pretty darn sure is no account."

"I thought that you told me that all turbine runners are designed with so many per cent. spouting velocity here and so many there?"

Pop's hands dived into his pockets. After he went the rounds two or three times, he dragged out a wrinkled and worn paper which he opened and studied a moment. "Here is a table that our friend the lecturer give me some time ago. In the first column of figgers, which is on the rated diameter as shown in the runner sections in Fig. 3, you have the percentages you're hollerin' about. Also it gives you the angles *a* an' *b* at the runner inlet that has been found by experience to go well together. But don't git the idee that you couldn't make a good runner with slightly different angles, because runner design ain't bound by no hard an' fast rules.

Designation	Per Cent. of Spouting Velocity	*V* Ft. per Sec.	Angle *a* Degrees	Angle *b* Degrees
Low to medium	64	5.14	15	60
	67	5.38	25	90
Medium to high	70	5.62	30	100
	73	5.85	32	108
	76	6.10	34	115
High to ultra-high	79	6.34	36	120
	82	6.58	38	130
	85	6.82	40	140

"Now as to what that *V* means, the spouting velocity for one foot head is 8.02 ft., as I showed before. If you go an' multiply 8.02 by the percentage, you'll git the value of *V* for that particular runner, it bein' nothin' more nor less than the velocity of the runner in feet per second reduced to one foot head, which yer can do by dividin' the velocity of the runner at the given head by the square root of that head. The angles *a* an' *b* is shown on the drawin' of the high-speed runner in Fig. 2."

That much being settled, Jimmy took a squint at Fig. 3 and foundered on the first word he saw. "What does 'type' mean Pop?"

Pop dumped the ashes from his pipe, refilled it and soon had steam up again. "Jimmy, a guy once said they was only about five distinct varieties of chickens, from the plain Plymouth Rock to the Broadway Midnight kind. He woulda been nearer right if he had said runners. We have the low-speed low-capacity type, medium-speed medium-capacity, high-speed high-capacity and ultra-high-speed high-capacity types. It ain't a thing that you can say here is where this type leaves off an' where this one begins, 'cause one type gradually grows into the other. They was a time not so long ago when they would call a runner with a shape like type C a honest-to-goodness high-speed runner, an' designers in them days uster think that they was walkin' on pretty thin ice, not bein' at all sure that the contraption would give the power on account of the exit velocity—or, as it's sometimes called, the discharge velocity—bein' as much as 11 per cent. of the head; meanin' by that, as I told you before, that you takes 11 per cent. of the head an' then finds the velocity due to that head."

"But tell me, Pop, is a runner like type C necessarily a high-speed runner because it's got a shape like that?"

"Well, not necessarily. For instance, I could take a

runner somewhere between type B an' C an' design it with a very low discharge velocity in the upper part of the draft tube an' which would give me a big bulge there on account of needin' so much area, an' to all intents an' purposes it would be a high-speed runner until you got to rakin over the figures kinda close. Then you'd see in a jiffy that the high-speed shape was only apparent, to use a high-brow word.

"In order to show the difference in shape, I've drawed

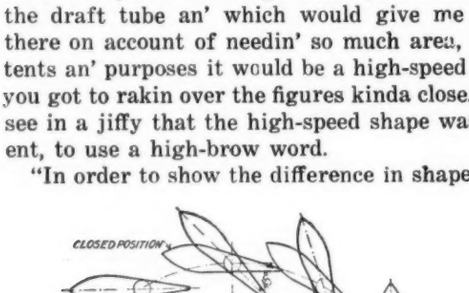


FIG. 1. SHOWING GATES IN OPEN AND CLOSED POSITION

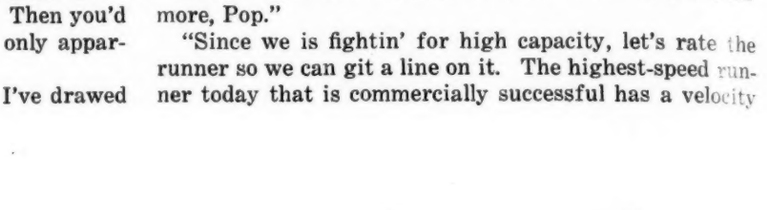


FIG. 2. THREE RUNNERS DESIGNED TO BE USED WITH THE SAME CASING

five runners in Fig. 3, all for 14 in. in diameter an' for the same r.p.m. In actual practice they would all be different speeds, my object bein' to compare the shapes. Now you'll also mind that the power of them all is different, an' that is the reason the runners is bulged out—to git the area down in the draft tube. You remember the ideal runner we designed in a previous talk? Well, the discharge was straight, about like type A. Makin' the discharge end of the runner vane curved like it is in the higher-speed shapes gives you more area. So far as the figgers go, when the discharge is made curved, the calculations ain't so safe as they is when the discharge is simply a straight line, 'cause it's harder to tell just which way the water may go an' just that little difference is what means that you git the proper amount of power or you don't.

"The place for measurin' the diameters is a chip on the shoulders of many turbine designers. On runners of types A, B an' C they is pretty well agreed that you should call *X* the runner size. When it gits to types D an' E, an' which is the way most runners look like today, some argues that you should call *Y* the diameter an' still others says that it must be *Z*. I belong to the last-named gang fer the reason that the diameter *Z* is a better gage for measurin' the water quantity, which is a blood relative to power, power bein' the much-desired thing in this type of runner. Anybody can git mere high speed by jes' reducin' the diameter of the runner, but to git high capacity along with high speed —thats the thing!"

"Your idea don't sound so darn bad. Let's hear more, Pop."

"Since we is fightin' for high capacity, let's rate the runner so we can git a line on it. The highest-speed runner today that is commercially successful has a velocity at *Z* of 68 per cent. of the spoutin' velocity of the total effective head; or, deductin' runner friction, etc., 75 per cent. of that of the net effective head. That leaves only 25 per cent. of the spoutin' velocity due to the net head for producin' reaction at the dicharge."

"It's a hard world, Pop; but tell me, do they have any method of telling by comparison which type of runner or which runner of a bunch is the best for that particular job?"

"Now we're comin' to it!" exclaimed Pop, all smiles.

"Coming to what? The hidden treasure?" echoed the surprised Jimmy.

"Yep! The type characteristic, alias specific speed. The real definition of specific speed is that it is the num-

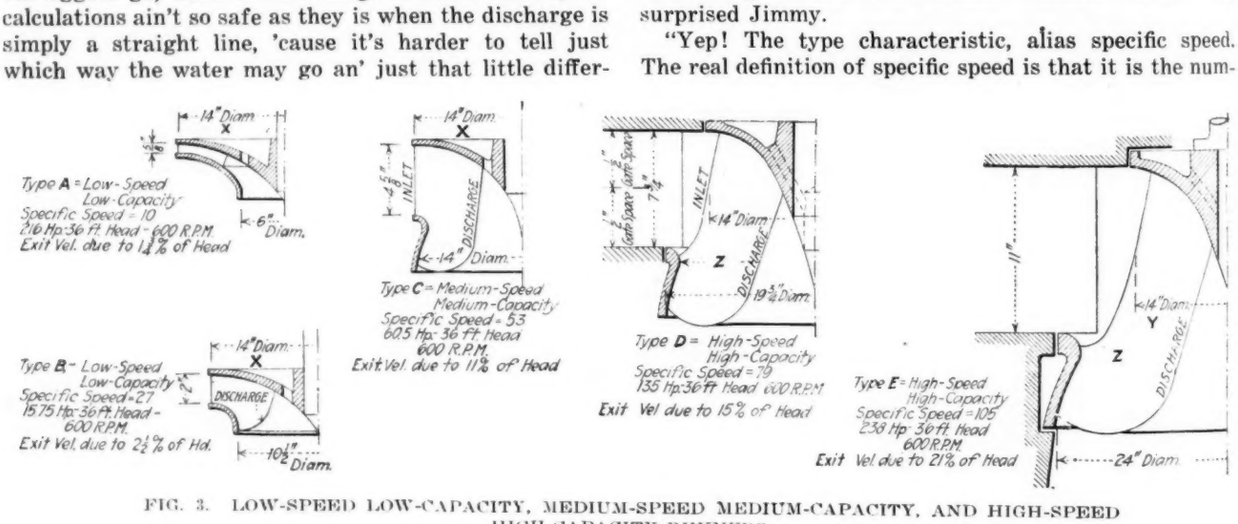

Type A = Low-Speed Low-Capacity
Specific Speed = 10
216 Hp: 36 Ft. Head - 600 R.P.M.
Exit Vel. due to 1¾% of Head
14" Diam.
6" Diam.
Type B = Low-Speed Low-Capacity
Specific Speed = 27
1575 Hp: 36 Ft. Head - 600 R.P.M.
Exit Vel. due to 2½% of Hd.
DISCHARGE
10½" Diam.
Type C = Medium-Speed Medium-Capacity
Specific Speed = 53
605 Hp: 36 Ft. Head 600 R.P.M.
Exit Vel. due to 11% of Head
INLET
DISCHARGE
14" Diam.
Type D = High-Speed High-Capacity
Specific Speed = 79
135 Hp: 36 Ft. Head 600 R.P.M.
Exit Vel due to 15% of Head
INLET
DISCHARGE
19⅝" Diam.
Type E = High-Speed High-Capacity
Specific Speed = 105
238 Hp: 36 Ft. Head 600 R.P.M.
Exit Vel due to 21% of Head
DISCHARGE
24" Diam.

FIG. 3. LOW-SPEED LOW-CAPACITY, MEDIUM-SPEED MEDIUM-CAPACITY, AND HIGH-SPEED HIGH-CAPACITY RUNNERS

"The place for measurin' the diameters is a chip on the shoulders of many turbine designers. On runners of types A, B an' C they is pretty well agreed that you should call *X* the runner size. When it gits to types D an' E, an' which is the way most runners look like today, some argues that you should call *Y* the diameter an' still others says that it must be *Z*. I belong to the last-named gang fer the reason that the diameter *Z* is a better gage for measurin' the water quantity, which is a blood relative to power, power bein' the much-de-

ber of revolutions per minute that a wheel or runner 1 ft. in diameter developing 1 hp. makes under 1 ft. head. Some engineers calls it the type characteristic, an' since it ain't libel an' they ain't no law agin it, they gits away with it. Specific speed means more to me than type characteristic do, but some argues that the word 'speed' tends to confuse r.p.m. with velocity, the only difference bein' that they is second cousins instead of first. I likes the word 'specific', 'cause it carries with it the idee of unity, referrin' the speed to 1 ft. head. The practical definition means that it is the product of the speed in r.p.m. of the runner under 1 ft. head times the square

root of the horsepower under 1 ft. head. Fer instance, if we had a runner givin' 50 r.p.m. under 1 ft. head an' also 4 hp., we multiply 50 by 2, which is the square root of 4, an' git 100, the specific speed or the type characteristic. Jes' fer another example showin' how it's done, take a runner givin' 2000 hp. an' 100 r.p.m. under 16 ft. head. We find the specific speed as follows: The r.p.m. bein' proportional to the spoutin' velocity an' the spoutin' velocity as the square root of the head, we divide the r.p.m. by 4, which is the square root of the head, an' git 25 r.p.m. for 1 ft. The power under 1 ft. is found a little different. We gota remember that with a runner which has a constant discharge area, the power is proportional to the velocity of the water flowin' through it as well as the head. That means that we gotta divide the 2000 hp. by 4, the square root of the head, an' also by 16, the head itself. Doin' this is what they calls dividin' by the three-halves power of the head, the square root often bein' called the half-power and the head of course bein' the first power of itself, the two added makin' the three-halves power. So dividin' 2000 by 4 an' then by 16 is the same as dividin' by 64, which gives us 31.3, the power of the runner under 1 ft. head. Now the square root of this 1 ft. head power is 5.6, an' that multiplied by 25, which you will remember was the r.p.m. under 1 ft. head, gives us 140, the specific speed."

"Wouldn't it be nice to have a table of the three-halves powers, Pop?" asked Jimmy.

"I don't see that you needs any more than a table of square roots, an' which you'll find in darn near every handbook worth the name."

"The next time we'll see how the turbines is built, meanin' the construction details an' the mountin's. That about finishes up the subject of tubines, an' then we dooly takes up an' studies the Pelton wheel, alias the impulse wheel an' the tangential wheel, and when we get through you'll know more than you do now."

Getting a Refrigerating Plant Out of a Critical Situation

By J. C. MORAN

In the face of increasing load demands the three ammonia compressors could not be made to carry the normal load. The troubleman diagnoses the case and finds, after investigation, that simple remedies will make it unnecessary to install about 100 tons additional capacity, or to operate all three machines together to supply service.

EQUIPMENT in the plant in question consisted of a number of electric generating units which supplied power and light to a little town, the necessary boilers and auxiliary equipment and three refrigerating machines of 50, 75 and 100 tons capacity respectively. These handled a cold-storage plant and two ice tanks.

The load on the cold-storage plant had been increasing gradually until it was impossible to keep the temperatures down and at the same time pull the ice tanks at full capacity. The operators had done everything in their power to get the highest capacity out of the machines. The cylinders had been rebored, new pistons and rings fitted, new valves put in some of the machines and the rest ground in, and the condensers and expansion coils had been given a thorough cleaning both inside and outside; regularly every other day some of the men went over the coils and scraped the frost from them, but the cooler temperatures would persist in remaining higher than they should be for the kind of goods stored.

Evidently, there was nothing to do but buy another machine, as they were considering building another story on top of the cold-storage plant and this would require additional refrigerating capacity. Consequently, the chief engineer was asked to make an estimate as to the capacity of machine required and also the additional amount of piping necessary. The writer, a friend of the chief's, was invited to assist him solve the problem. The plant appeared to be in tiptop condition. After having talked over the problem in general, we made a trip through the coolers, estimated the amount of pipe in each, noted from some old blueprints the amount of insulation in each room, and from the quantity of ice pulled in connection with the other data each 24 hours we then set down to figure out the estimated load. Not satisfied with the first results, the total coil surface in each room and ice tanks was taken and the heat transmission estimated. All I could get at the highest was the equivalent of a little over 140 tons, while according to the rated capacity of the machines they should be pulling about 225 tons.

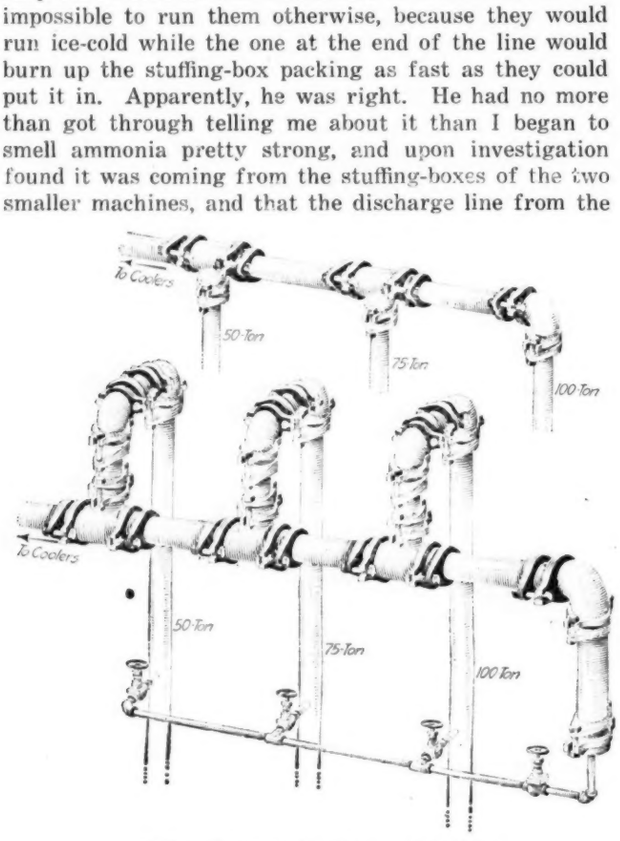
We went back and checked the figures of the pipe surface, room temperatures and insulation over again. The figures were right. We turned our attention to the machines, particularly to the suction pressure, but this was good for the temperatures carried; from the temperatures of the discharge lines of the machines they were all working to the best advantage.

After investigating everything from the basement to the roof, we decided to indicate the compressors. I was getting suspicious of two of the machines, the two smaller units, thinking they were "lying down on the job" because the governors were riding unusually high and the cutoff was short. Suspicions were substantiated when the diagrams were taken. Two of the machines were probably handling not over 30 per cent. of their rated load. Instead of 12 lb. suction pressure, which the gages showed, and which also showed the same on the card from the large machine, these machines indicated a suction pressure in the cylinder of about 10 in. vacuum. Either there must be something wrong with all the suction valves of the two machines or there must be an obstruction in the suction branch to each of the machines on which there was trouble because the machine that was doing most of the work was at the end of the line and in case of obstructions in the main line would have been affected the same as the others.

Without any particular purpose in mind I gave one of the suction stop valves a twist. To my surprise I

continued turning until I thought that the threads on the stem must be gone, when the valve finally stopped and would turn no farther. Evidently, the valve had been nearly closed. The same condition was found on the other machine on which trouble was experienced. The large machine that was working properly had its valve wide open.

One of the engineers happened to come around at this time, and I asked him about the valves. To my surprise he said he was well aware of it and that it was impossible to run them otherwise, because they would run ice-cold while the one at the end of the line would burn up the stuffing-box packing as fast as they could put it in. Apparently, he was right. He had no more than got through telling me about it than I began to smell ammonia pretty strong, and upon investigation found it was coming from the stuffing-boxes of the two smaller machines, and that the discharge line from the



HOW THE PIPING WAS ARRANGED

50-ton machine, as illustrated in the sketch, was as cold as ice; the discharge from the 75-ton machine was a little warmer, but much too cold for efficient operation.

The 100-ton machine at the end was just the reverse, however. The stuffing-box was beginning to smoke, and some quick work was necessary to keep it from burning out at once. The discharge line was so hot that it smoked. To bring things back to normal we had to choke off the suction valves again on the 50-ton and 75-ton machines.

The trouble was caused by too much liquid in the suction gas, and this was hard to prevent because it was necessary to work some of the small coils in the low-temperature rooms to their greatest capacity and a little liquid would carry over into the suction line at times with the closest regulation. The result was that with the piping shown in the top view the 50-ton machine got most of this liquid and the 75-ton machine the rest. The 100-ton machine got nothing at all and ran too hot.

By throttling the suction valves of the two machines, the gas was partly superheated and evaporated some of the liquid in the suction gas. Also, this increased the ratio of compression several times, which further tended to heat the gas when it was finally discharged from the machine. It also reduced the capacity of the machine so much that sufficient liquid was carried past them to keep the 100-ton machine cool. This, by the way, is not the first time I have seen the same remedy used for this trouble, and it is always done by men who pride themselves on their *practical* experience. A man thoroughly posted on the principles of ammonia compression would never attempt such a makeshift.

How the Trouble Was Solved

The solution of this trouble was simple. We took the connections for the individual branches to each machine from the top of the main line instead of the bottom, as shown in the lower view. From this it will be seen that we merely applied the principles that even a "dub" knows about steam piping. It seems peculiar that some men can see things as plain as daylight in one case and be blind as a bat on the same problem in another case, simply because it has a different name.

The main line was continued for about four feet past the connection to the 100-ton machine. An elbow with a short piece of pipe with blind flange on the bottom was put on the end of the pipe, as shown at the right. The blind flange was tapped for a ¾-in. pipe, and this was connected to the suction lines as shown.

This allowed the amount of liquid carried to each machine to be closely regulated simply by adjusting the valves according to the temperature of the discharge. After this was done the 75-ton machine was shut down and the load carried with the 50-ton and 100-ton at a considerable reduction in the speed.

After this job was finished the writer was asked for further suggestions as to improvements. It was recommended that about 6000 ft. of pipe be added, to be distributed around the various coolers, particularly two low-temperature freezers, where a temperature of 15 deg. was carried. These rooms were lightly piped for the load and temperature they had to carry; to get results the suction pressure had to be kept low enough to make the increased temperature difference between the boiling ammonia and the room make up for the insufficient piping. This suction pressure was much lower than it was necessary to carry for the rest of the plant if sufficient pipe surface was provided. The result was that the machine capacity was reduced and the power cost increased.

About 3000 ft. of pipe was put in the two freezers, and when this was done it was possible to keep them at the proper temperature with a suction pressure of about 20 lb. This meant an increase in capacity of the machines of about 25 per cent. at the same speed. By speeding up the 100-ton machine to about 75 r.p.m., from 60, at which it had formerly been run, it was easy to handle the whole load with the one machine in the warmest weather. After the new story was built, the load was handled easily, even in the warmest weather, with the 50-ton and 75-ton machines, and the 100-ton unit was shut down. When the weather moderated, the 100-ton unit handled it nicely alone and often the 75-ton machine could handle it.

Any reputable boiler manufacturer can guarantee the efficiency of a boiler if he knows the quality of coal that will be used, in order that the proper ratio of grate and heating surface area can be provided.

The Electrical Study Course—Methods of Obtaining a Three-Phase System

It is shown how a three-phase system can be obtained by the use of three single-phase generators connected in delta or star. Also, how a three-phase system can be obtained from a single generator with three windings on its armature, or with a single generator with only one winding on its armature.

IT WAS found in the preceding lesson that a two-phase system consisted of two single-phase sources of the same frequency and voltage, but differing in phase by 90 deg. Similarly, a three-phase system is one that combines three single-phase sources of the same frequency and voltage, but differs in phase by 120 deg. Such a system could be derived from three similar generators coupled together, the taps of whose windings occupy positions relatively 120 deg. apart, as in Fig. 1, or from a single machine with three windings, Fig. 2. In generator 1, Fig. 1, the taps a_1 b_1 are in a position where the armature generates maximum voltage. In generator 2 the armature is shown turned counter clockwise through an angle of 120 deg. from the maximum position, while the armature of generator 3 is shown turned through an additional 120 deg., which brings it also 120 deg. away from a_1 of machine No. 1. In spacing the taps as shown, each tap a is 120 deg. away from any other tap a, and, similarly, each tap b is 120 deg. from any other tap b, thus making the entire arrangement symmetrical. If the voltages of the three generators are alike, as assumed, they would constitute a three-phase system, of which it would be said that wires AB are one phase, wires CD another phase, and wires EF, a third phase.

Six wires are not usually used for three-phase transmission, which is generally accomplished by the use of three wires only, by connecting three windings on one generator, Fig. 2, either as shown in Fig. 3 or as in Fig. 4. The same thing could be applied with the three generators, Fig. 1, by grouping them as in Figs. 5 and 6; the former of these is shown as the delta connection and the latter as the Y or star connection. Judging by appearance it might be concluded that the arrangement shown in Fig. 5 would cause a short-circuit of the generator. Such, however, is not the case. An examination of the relation between the voltages will show why. Suppose that the connection at W is allowed to remain open and a voltmeter be connected between A and F, it will be found to indicate no voltage. To understand this, let us add the voltage of generator No. 1 to that of No. 2 and then add the voltage of No. 3 to the former and find out what the total voltage between A and F ought to be.

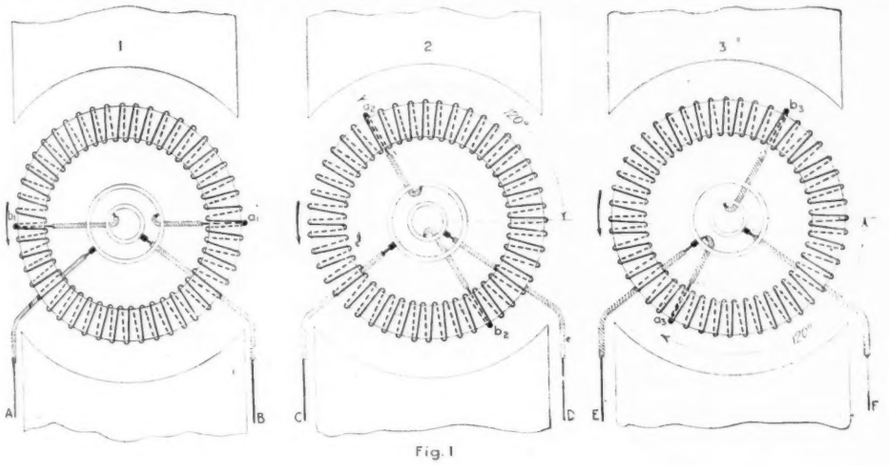


Fig. 1

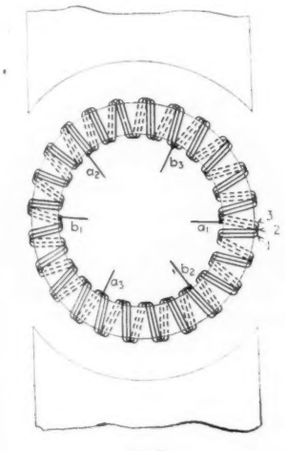


Fig. 2

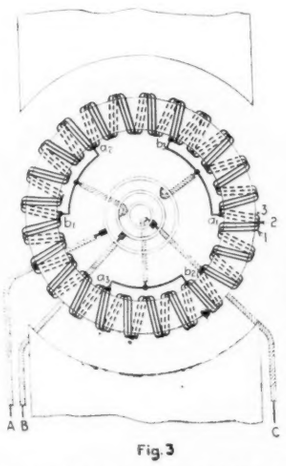


Fig. 3

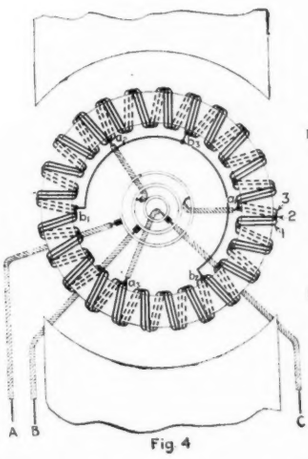


Fig. 4

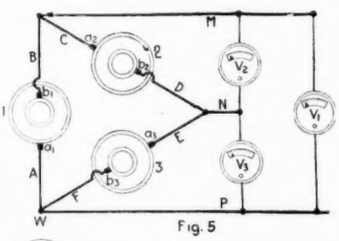


Fig. 5

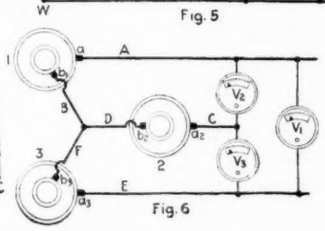


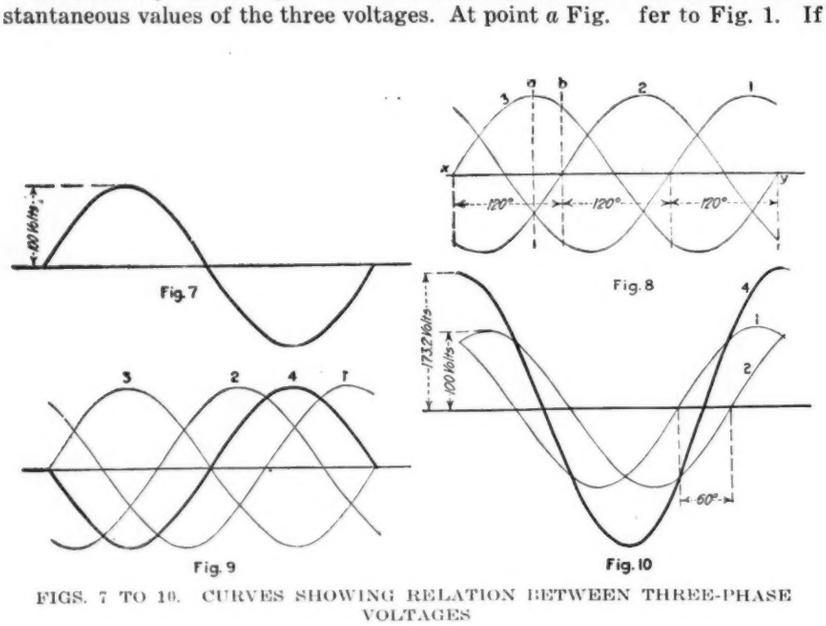
Fig. 6

FIGS. 1 TO 6. DIAGRAMS OF DIFFERENT METHODS OF OBTAINING A THREE-PHASE SYSTEM

Fig. 1—Three single-phase generators connected 120 deg. apart. Fig. 2—Three windings on one armature with taps brought out 120 deg. apart. Fig. 3—Three windings on one armature connected in delta. Fig. 4—Three windings on one armature connected in star. Fig. 5—Three single-phase generators connected in delta. Fig. 6—Three single-phase generators connected in star.

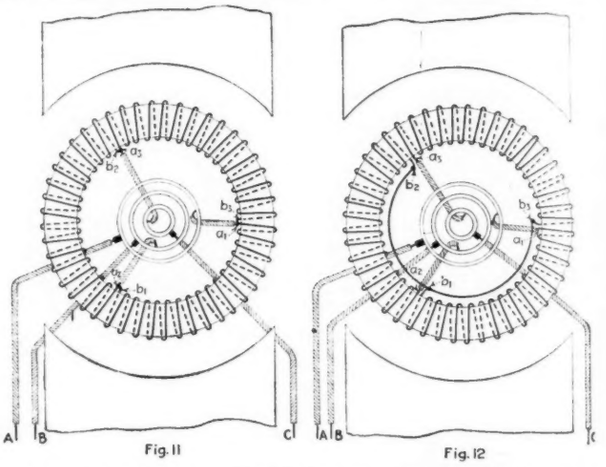
The voltage of each generator can be represented by a sine curve such as that shown in Fig. 7. Assume that the maximum value of this curve is 100 volts as shown. Although the three voltages may be each represented by such a curve, yet, when the three are represented at the same time they must be placed so as to show the phase difference between them. Thus, in Fig. 8 curves 1, 2 and 3 represent the voltages of generators Nos. 1, 2 and 3 respectively. It will be seen that the zero point of the curves are 120 deg. apart, that is, one-third of 360 deg., or one-third of the distance from x to y, which is the distance of a complete cycle. When curves 1 and 2 are added, we get the result indicated by curve 4 in Fig. 9. It will be seen that this curve is exactly like curves 1 and 2, but that it lies midway between them. The voltage represented by curve 4 is what exists between points A and D in Fig. 5. If we now wish to add curve 4 to curve 3, the voltage of generator 3, it will be seen that they are equal and opposite. Consequently, the resultant voltage is zero; that is, the voltages represented by the curves just neutralize each other. Hence, there will be no voltage between A and F and the two terminals may therefore be safely connected together as at W in Fig. 5. The system as illustrated in Fig. 5 will therefore provide three equal voltages 120 deg. apart, one across MN, another across NP and a third across MP. The three voltmeters, V_1, V_2 and V_3 will consequently read alike, each indicating the maximum voltage times 0.707. In this case we assume the maximum voltage to be 100. Therefore, the voltmeters will read, $100 \times 0.707 = 70.7$ volts.

Another way of looking at this is to consider the instantaneous values of the three voltages. At point a Fig. 8 the voltage of generator No. 3 is at a maximum and that of Nos. 1 and 2 is at half value and in opposition to that of No. 3, consequently the resultant of the three e.m.fs. at this instant is zero. At point b No. 2 is zero and Nos. 1 and 3 are of equal values but in opposite direction, one being above the line xy and the other below, consequently the resultant of the voltages is again zero. This will be found to be true for any instant on the curves, the sum of the instantaneous values above the line xy are equal and opposite to those below.



FIGS. 7 TO 10. CURVES SHOWING RELATION BETWEEN THREE-PHASE VOLTAGES

In the Y connection, Fig. 6, a terminal of each generator is connected to one terminal of the other. In making this connection, like terminals are connected together; that is, either all the a or all the b rings are connected together; in the figure the b rings are so shown. From the diagram it is apparent that the voltage across AC is the resultant of the voltages of generators 1 and 2, that the voltage across CE is the resultant of the voltages of generators 2 and 3 and that across A and E is the resultant of the voltages of generators 1 and 3. The problem then is to determine the value of these resultants. To do so, refer to Fig. 1. If terminal b_1 of generator No. 1 is connected to terminal b_2 of No. 2, the voltages of No. 1 and No. 2 no longer have a 120-deg. relation but only a 60-deg. relation. That is, it makes a difference of 60 deg. whether the voltage of generator No. 2 is added in the direction a_2 b_2 or in the direction b_2 a_2. Since the voltage of No. 2 is 60 deg. ahead of that of No. 1 instead of 120 deg. behind, as in Fig. 1, the sine curve for No. 2 will, so far as its effect on the addition is concerned, have to be shown in the position indicated in Fig. 10, instead of that indicated in Figs. 8 and 9. The resultant will then be expressed by curve 4, Fig. 10.



FIGS. 11 AND 12. THREE-PHASE SYSTEM FROM ONE ARMATURE WINDING

Another way of looking at this is that the connection of No. 2 generator has been reversed relative to No. 1 machine. In the delta connection No. 2 machine, Fig. 5, a_2 is connected to b_1 of No. 1 machine, where in the Y connection, Fig. 6, b_2 of No. 2 machine is connected to b_1 of No. 1 machine, that is, the connection of No. 2 machine in the latter case has been reversed. Therefore if the connection on No. 2 generator has been reversed, its voltage has been reversed relative to that of No. 1. Thus, by reversing curve 2, Fig. 8, that is the part of the curve below the line is put above and the part above placed below, we will get a relation between curves 1 and 2 as shown in Fig. 10, and the combination of these two curves will give curve 4, which, it

will be seen, is considerably greater than either 1 or 2. In Fig. 9 combining curves 1 and 2 gave a resultant curve having the same value as 1 and 2; in Fig. 10 the maximum value of the resultant curve is 1.732 times as great as that of 1 or 2. This is due to the voltage having a 60-deg. phase relation in the latter case and a 120-deg. phase relation in the former.

The maximum height of No. 4 curve, Fig. 10, is 1.732 times No. 1 or No. 2. Then if the latter is 100 volts, the former is $1.732 \times 100 = 173.2$ volts. In Fig. 6 voltmeter V_2 will indicate $173.2 \times 0.707 = 122$ volts. Following the same method as in the foregoing, it will be found that the voltage across *CE* in Fig. 6 is equal to resultant of that from generators Nos. 2 and 3. These voltages are 60 deg. apart and consequently their resultant will be 122 volts. In precisely the same manner the voltage between *A* and *E* is found to be 122 volts. We therefore have three electromotive forces each equal to 122 volts.

The system illustrated in Fig. 6 is a true three-phase one, since the three voltmeters V_1, V_2 and V_3 each read 122 volts and the voltages are 120 deg. apart.

What is true of the three single-phase generators connected in delta, Fig. 5 and in star Fig. 6, is also true when three windings are used on the same armature, as in Figs. 3 and 4. If the three windings are connected star, as in Fig. 4, the voltage at the terminals will be 1.732 times as great as when connected delta, Fig. 3. Two of the standard voltages for three-phase alternating-current generators are 6600 and 11,000 volts. One of the reasons for their adoption is that $6600 \times 1.732 = 11{,}000$, approximately. That is, if a three-phase alternator is designed to generate 6600 volts when connected delta, the same machine would generate 11,000 volts with its windings connected star.

Another method that can be employed to obtain a 3-phase system is to use a single winding and divide it into three parts, as in Figs. 10 and 11. Such a winding would be used for a delta connection by connecting together b_1 and a_2, b_2 and a_3, and b_3 and a_1, and then bringing out three taps to three rings as in Fig. 11. A star connection can be obtained by connecting all the *b* terminals and bringing out the *a* terminals to the slip rings as in Fig. 11. Or, vice versa, all the *a* terminals could be connected together and the *b* terminals brought to the slip rings. With such a machine three separate and equal voltages could be obtained with the voltage from the star connected winding 1.732 times as great as that from the delta connected winding.

A three-phase generator has three separate windings, each of which generates 2300 volts. What would be the voltage per phase with delta connection? What with Y connection.

If a voltmeter reads 2200 volts when connected across an alternating-current circuit, what is the maximum value of the supply voltage?

Shells of various caliber have proved by experiments to have considerable commercial possibilities. The steel of which they are made is in many cases capable of being rendered glass hard, and milling cutters have been produced which have stood the most exacting tests. After a little manipulation on a lathe, an 18 pounder shell, minus nose and copper rotating band, makes an excellent shafting coupler. The 6-in. shell in the same way becomes a fine flexible coupling. Many other uses of this material have been devised.

Neglected Parts of Water-Tube Boilers

By Warren D. Lewis

Perhaps the most neglected parts of water-tube boilers are the front and rear headers with their respective handhole fittings.

It is usually a hot, dirty job to clean headers and caps, and as for closing up the boiler, this is usually done as quickly as possible, the front and rear doors shut, and the whole thing forgotten until possibly a cap gasket blows out or the regular overhauling and cleaning time arrives. When the doors are opened, everything is usually covered with a white scale which is hard to remove.

Now, this condition makes extra work, which is unnecessary. The time to begin to prevent it is when the boiler is new. Headers are sometimes painted by the boiler manufacturer to prevent rusting, but usually not even this precaution is taken. If at this time the headers were rubbed down with plain flake graphite mixed with a little water as a carrier, and the tube holes, caps and dogs treated the same way, any deposit from a leaky cap could be easily removed with a stiff wire brush.

When closing up the headers it should not be attempted to pull the caps up to their final position. While the boiler is filling with water, leaks should be looked for and corrected even if it is found necessary to empty the boiler again. As the temperature rises the caps should be gone over and tightened, and again when the boiler goes into service, under full steam pressure. If the caps are watched for a day or two for leaks, the doors may then be closed with the assurance that there will be no dirty looking headers a few weeks or months later. Of course it is possible that with an old boiler the preceding method is not the whole solution of the problem, but leaks from caps are usually due to carelessness.

Most boilers are now equipped with inside caps, and here the pressure assists in making the cap tight. To clean the bearing or joint surface of an outside cap is a simple operation, especially with the aid of a resurfacing machine; but cleaning the header for inside caps is an awkward, tiresome job. A poorly cleaned header will usually cause the caps to leak. One way to prevent this is to inspect the header by means of a small mirror held inside, light being supplied by an electric lamp. This will show any dirt on the header and is much more satisfactory than passing the fingers over the surface. For round inside caps there is a simple, inexpensive machine made which will scrape the surface inside the header better and quicker than can be done by hand. I have never heard of a machine to scrape the surfaces of elliptical holes.

The selection and use of handhole gaskets is an important part of this work. There are several kinds, the most common ones being either of asbestos rubber or semimetallic, these last being composed usually of a thin copper or soft-steel ring with an asbestos core. I prefer the semimetallic gasket as it usually makes less work in cleaning headers and caps when removed. If the asbestos or rubber gaskets are rubbed well with graphite, they are not likely to bake on the metal and cause trouble when removed. Notwithstanding the small additional cost of the semimetallic gasket, the labor saved makes it, I believe, the cheapest in the long run.

Improved Green Steam-Jet Ash Conveyor

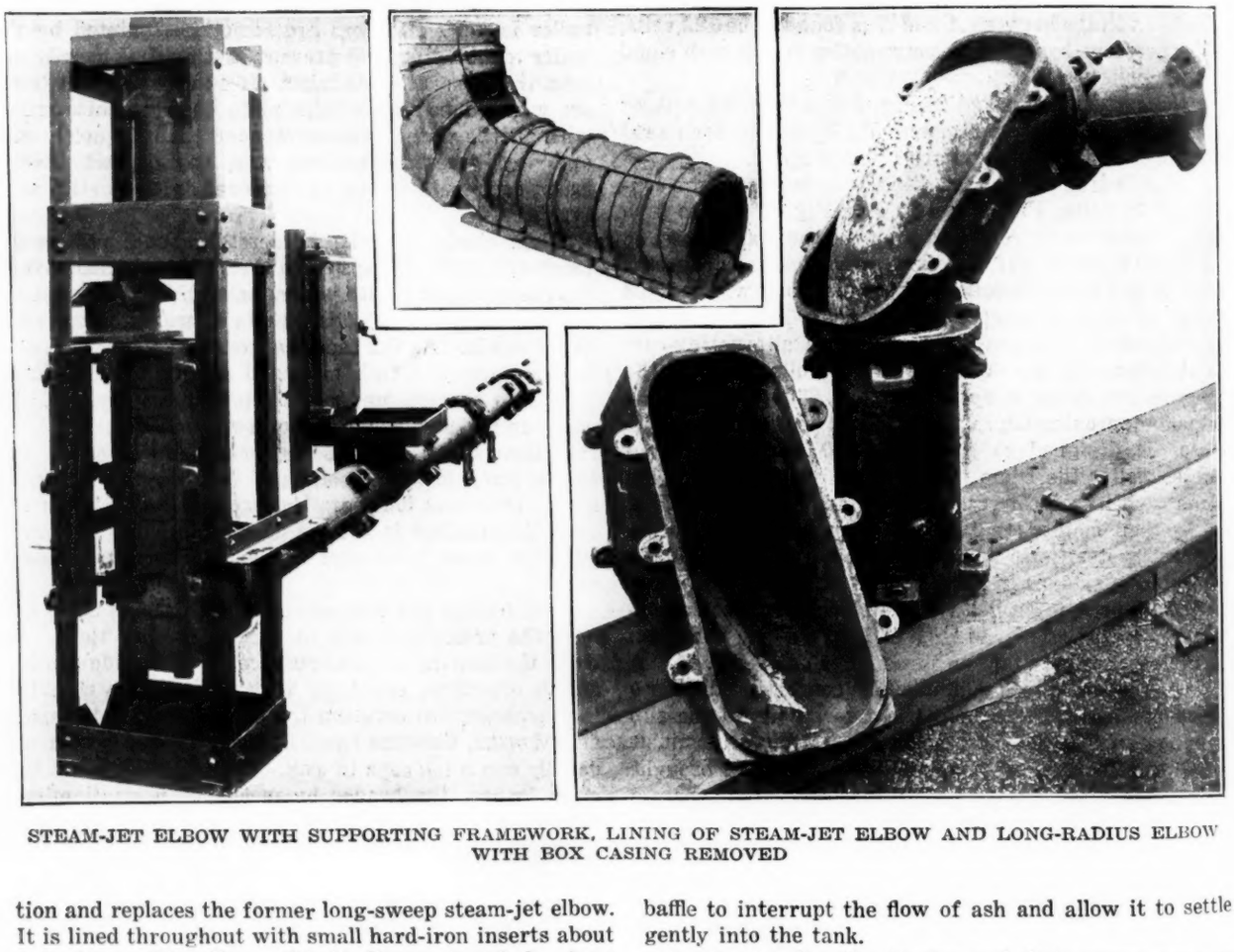
Some of the more prominent features of the steam-jet ash conveyor made by the Green Engineering Co., of East Chicago, Ind., are shown in the accompanying illustrations. In the new system an improvement is the provision of roller supports, expansion joints and fixed anchorage between such expansion joints. The metal being extremely hard is necessarily brittle and subject to breakage. All joints are ground and a thin tar-paper gasket permits an air-tight joint to be made at the time of the installation and experience indicates that the joint will remain tight after the system has been in operation.

The new steam-jet elbow is of square turn construction and replaces the former long-sweep steam-jet elbow. It is lined throughout with small hard-iron inserts about 6 in. long. The elbow with its liners rises 3 ft. above the steam jet. The division of the wearing back provides for renewal at any point where extreme wear may occur. A hinged back cover gives access to the elbow for regular inspection and renewals when necessary. A substantial structural steel frame supports the elbow and the vertical pipe run.

As a further safeguard for minimum maintenance cost a 2-ft. pipe section is connected above the elbow. If heavy wear does extend beyond the elbow it will require the renewal of only the 2-ft. section instead of a long section that is worn at but one end. This section may be turned through four 90-deg. positions, reversed and again thus turned before it must be renewed.

Where no steam jet is necessary an "ash pack" long-sweep elbow is used. In this case the point of wear is not influenced by the steam jet and invariably occurs at the back of the fitting. A substantial back is provided to take the initial wear from the ash and this is surrounded by a box casing packed with ash at the time of installation. Eventually the ash in the conveyor drills a hole in the wearing back and thereafter it is projected against the ash pack between the casing and the back. The wear is then limited to ash upon ash.

In delivering the ash to the storage tank much the same principle is employed. On top of the storage tank is the usual tank box which the conveyor pipe enters horizontally. On the opposite side of the box is a thimble-shaped receptacle filled with ash to take the impact of the conveyor discharge. It replaces the hard-iron baffle formerly used. Below the box is a horizontal baffle to interrupt the flow of ash and allow it to settle gently into the tank.



STEAM-JET ELBOW WITH SUPPORTING FRAMEWORK, LINING OF STEAM-JET ELBOW AND LONG-RADIUS ELBOW WITH BOX CASING REMOVED

In the pipe line the intakes and their covers are provided with ground joints to prevent air leakage at these points. All overhead pipe runs, as well as the elbows, are hung from a permanent structural steel frame so that renewals can be effected without tearing down the entire line.

Failure of the pine cap of a timber trestle erected for falsework on bridge construction led to the testing, by the Bureau of Standards, of the crushing strength of this material perpendicular to the grain. A 12 x 12-in. block was loaded in the large testing machine by being placed crosswise between two blocks of the same size under a load of 200,000 lb. The thickness of the cross-block was reduced from 12 to 6 in. at a pressure of about 1380 lb. per square inch.

EDITORIALS

Doctor Succeeds Dentist as Chicago's Smoke Inspector

FOUR years ago, shortly after the change in administration, a dentist was appointed as chief smoke inspector of the City of Chicago. Such a selection was commonly regarded at the time as political, for the appointee did not have the mechanical qualifications called for by the ordinance. It was claimed that a good executive could fill successfully this position and that detail knowledge of combustion and mechanical engineering in general was not essential. Evidence from the last four years does not confirm these contentions.

In 1915 Chicago's smoke department held an enviable reputation. From all sections of the country came inquiries as to the methods employed, and it was generally conceded that the Chicago department in successful smoke abatement was the pioneer and the leading authority of the nation. From a position second only to Pittsburgh in its smokiest days, Chicago had become a comparatively clean city. The plan of coöperation with the owner and education of the plant operator, rather than an arbitrary imposition of fines on violators of the smoke ordinance, had been eminently successful. These results had been secured by an able corps of engineers and inspectors headed by men of mechanical training who were professionally superior to their subordinates and were competent to direct the work and pass judgment on the results obtained. Publicity in the daily press was used to advantage, and a smoke abatement commission of representative business men rendered invaluable assistance. The department had been maintained free from politics, a leading reason for its success.

From the year 1915 the department has been on the down grade. Its work gradually became less effective, until now Chicago is back to the old days of dirt and smoke. The conditions that existed last winter have, it is generally conceded, never been surpassed in the history of the city.

In 1915 the department had a personnel of thirty and an appropriation of about $42,000. Men were dropped gradually and the appropriation became less each year. By 1918 it had been reduced to $26,000 and there were only thirteen employees. The admirable work of the smoke abatement commission was not appreciated by the mayor, as he failed to reappoint a similar body. Fines were imposed less frequently, and violations for the most part were being overlooked. War conditions with the change in the coal made matters worse, so that the department, already inadequate, was completely swamped and its efforts had little effect on the deplorable conditions which were then existing.

When the same administration returned to office in April of the present year, it was hoped that some attention would be paid to the numerous complaints that had been made and that the department would be restored to its former state of efficiency. The chief smoke inspector was promoted to the more lucrative position of commissioner of public service, and the department was allowed to drift along without a cabinet head until appropriations for the year 1919 came up for consideration in June and July. At this time an appropriation was made for the department as the Bureau of Smoke Inspection of the Department of Health, and no provision was made for the salary of the chief smoke inspector. Contrary to usual procedure these transactions took place before enabling legislation had been passed by the council to permit the transfer of the authority of an independent department to the Board of Health.

In the meantime a subcommittee of three of the Committee on Efficiency and Rehabilitation met to consider the proposed ordinance for placing the smoke department in the ventilating division of the sanitary bureau of the Health Department. Dr. Robertson, health commissioner, would thereby be the nominal head of the smoke department, and being present at the meeting he proposed to attack the problem from a medical standpoint, treating the smoke nuisance as dangerous to health and summarily abating it if necessary, regardless of conditions in the plant. Violators of the smoke ordinance were to be fined heavily if they persisted in endangering the health of the community by producing visible smoke. He promised to use all avenues of publicity open to the health department and conduct an active campaign to create public sentiment against the smoke nuisance. There has been recent evidence of this policy in the daily press. For the technical direction of the department his authority would be transferred to Dr. Vernon E. Hill, a doctor of medicine and an engineer who for a number of years has conducted with credit the ventilating division of the Health Department. The ventilating inspectors were to coöperate with the smoke department and help eke out the limited appropriation that had been made for the current year.

Representatives of the Western Society of Engineers and of the City Club and other engineers were present to protest against the subordination of the smoke department. The work was large enough, they urged, and of such importance as to warrant an independent organization by which full attention could be given to the work in hand and there would be no diversity of interests. In years past the proposed plan of making the smoke bureau an adjunct of the health department had never been successful. An engineer-executive was considered essential, as he must be capable of directing the work intelligently and passing on results obtained.

With a doctor at the head of the department it was feared that the viewpoint would be medical rather than from the engineering standpoint of efficiency and economical operation of the plant. It was recognized that dense smoke was a serious menace to health, but it was only one of the objections to the smoke nuisance. Attacking the problem in an engineering way would

utomatically eliminate the danger to health, the injury o property and other nuisances and, of prime impor- ance financially, improve plant economy. Only an engineer-executive as chief smoke inspector could suc- cessfully cover all angles of the problem, and it was the view of the engineers that the smoke-abatement commission should be reëstablished. For these reasons they entered a decided protest against the proposed action.

With two members of the subcommittee present, and Dr. Robertson, who was insistent upon the change, it was decided that under the conditions the ordinance for the transfer of the smoke department should be passed and the matter should be presented to the committee as a whole. The main committee met on July 28, but, owing to lack of a quorum, no action was taken. The chairman of the subcommittee, however, assured the engineers who were present that no further action could be taken until the first meeting of the city council in November. Apparently he had not taken into account possible action by the mayor and that the proceeding had the earmarks of a prearranged plan.

During the week of August 25 it was announced in the daily press that Dr. Robertson, by an executive order of the mayor, had been appointed chief smoke inspector. With no salary now attached to the office, it is difficult to see any ulterior motive. Notoriety to be gained from a big publicity campaign might be a factor, but if anyone can succeed in ending the smudge that has blackened Chicago skies, he is entitled to all the glory there is in it. The council has yet to confirm the appointment and pass the enabling legislation to transfer the smoke department. They may consider themselves overridden and object to the high-handed methods that have been adopted.

It is still a number of weeks before November and the first meeting of the council. Engineers of Chicago have time to prepare their case, and it would seem that concentrated efforts for the good of the profession and for the health and welfare of Chicago citizens should be in order. There is no doubt that the plan for smoke abatement, as outlined by the engineers before the subcommittee, is the better of the two. It is comprehensive, covers all angles of the problem and in Chicago itself has been tried previously with eminent success. The proposed plan has also been tried, but has always been a flat failure.

Make it Easy To Be Right

THE engineer of a large electrical system gives as one of the elements of his successful handling of large power-plant problems his practice of making it easy to do the right thing.

Human effort, as well as mechanical force and electricity, follows the line of least resistance. If one makes it easier for his help to do things as he wants them done than to get by with them in any other way, they will be done as he wants them and without any pushing or driving or bawling out. So far as it lies in your power, make the way that leads to the greatest efficiency the easiest and most attractive way.

There are many hot, arduous and disagreeable tasks about a power plant. Sustained efficiency, even perhaps dependable operation, depends upon their being done, and done right. A boiler will be more conscientiously cleaned and inspected if it and its setting have been allowed to cool off before the men are made to enter them. The cleaning of the soot from the heating surfaces should be done at regular times or after a certain amount of service, determined by observation of the effect of such cleaning. The hand-cleaning operation is one that the average boiler-room help will shirk whenever possible and slight when they have to go through the motions. The modern method of blowers fixed in the setting, requiring but a few moments of operation at more or less frequent intervals, will keep the surfaces clean, enable them to absorb heat that would otherwise go to the stack, and is done at the expense of little if any effort on the part of the man in charge.

The cleaning of condenser tubes is a dirty, disagreeable job that the men will let go as long as possible. The engineer that we are quoting has a method of cleaning them with air-propelled plugs, which reduces the operation to fun and keeps the final pressure for his turbines at the lowest possible average level.

Even in the small plant much can be done by intelligent design, foresight and consideration to make the task of the man in charge easier and thus to insure its being better done. A change in the method of handling the coal and ashes, provision for adequate ventilation and a few little matters of this sort would often give a plant the pick of help and enable it to get better service from them.

"A horse! a horse! my kingdom for a horse!" cried King Richard III.

"O for a synchronous motor!" sighed the central-station manager who had let his system become surfeited with small partly loaded induction motors and transformers of such low aggregate power factor that he had to run two alternators instead of one in order to hold up the voltage.

The war taught Europe an object lesson in refrigeration. If it had not been for the tons of food stored in American warehouses, in Chicago and on the Atlantic seaboard and immediately available, the Allies might have lost the war. Because of this and the great warehouse built by our army in France, Europe has appreciated the value to her of refrigeration.

Engineering Council has requested President Wilson to fill the next vacancy on the Interstate Commerce Commission by the appointment of an engineer. The outcome will be taken as an index to the probable success of the present agitation for greater participation of engineers in public affairs.

Don't covet the boss's job until you are sure you would be safe in having it. You may misjudge the boss. If you could view yourself as the workman from the viewpoint of the boss, conscience might force you to fire yourself as a workman.

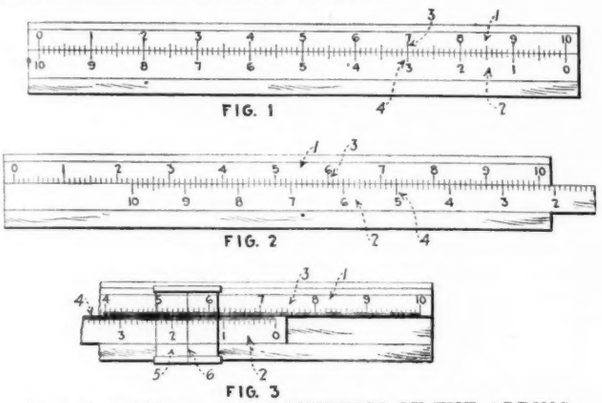
The man who tells the chief that he "can't" do something, either has a lot to learn about the business or else he thinks the chief is "kidding" him, in which case he will be better off when he gets another job.

What your plant needs most is your coöperation. It's not the ball players but the team that wins the pennant.

Correspondence

An Adding Slide Rule

In nearly every case college professors, mathematicians and practical engineers will be amused at the suggestion of an adding slide rule, but the device is so simple that any ordinary person can understand its operation. We all know that the fundamental structure of a slide rule consists of a movable scale and a stationary scale. Suppose the movable scale consists of ten equal spaces (Fig. 1) say 1 in. long, which are in turn subdivided into ten equal spaces. A further subdivision may be made as shown in Fig. 3, but for simplicity start with Fig. 1. Number the movable scale 0, 1, 2, 3, etc. (Fig. 1) and make the stationary scale exactly the same, except that the numbering be reversed —that is from left to right instead of from right to left. It is not necessary to reverse the scales, but for various reasons it is better to do so.



FIGS. 1, 2 AND 3. SOME SETTINGS OF THE ADDING SLIDE RULE

Suppose we wish to add 4 and 5. Take 4 on one scale (Fig. 1) and 5 on the other scale and place them in alignment. The result would be read on the stationary scale at the index 0, and is 9. Now suppose we wish to add 75 and 48. The numbers are placed in alignment as in the previous case, but this time the result must be read opposite the index 10 which appears to be 23. However, the sum of 48 and 75 is 123. Therefore, it is obvious that a figure one must be placed before the apparent result. In other words, every time a reading is made at the index 10 a figure one must be placed before the result shown on the rule, but, when a reading is made at the index 0, this is unnecessary.

By the use of the runner the sum of two numbers may be held so that another number may be added, and this process may be repeated indefinitely. In adding a long column of numbers, it is only necessary for the operator to set the numbers properly on the rule, as indicated, and count the number of times a reading is made at the index 10. Then the number counted is placed before the reading of the slide rule as a coefficient.

The process of subtraction is simply the reverse of addition. Suppose 172 is to be subtracted from 728 (Fig. 3). The index 0 is placed opposite 728 on the stationary scale, and the runner is brought to 172 on the movable scale. The result, 556, is read on the stationary scale opposite the runner.

With the scales calibrated to fiftieths or hundredths, it is possible to add columns of six or more digits, accomplished in the following manner. Suppose that the following example in addition is proposed:

654,329
761,846
977,762
2,393,937

the sum of which is as given.

To add the numbers on the slide rule, they are added first in columns of three figures, thus:

654	329
761	846
977	762
2,392	1,937

the sum of each column being obtained separately. Then, the last figure in the first column and the first figure in the last column are added in this manner:

2,392
1,937
2,393,937

If the sum of the first figure in the last column and the last figure in the first column should be greater than 9, the first figure in the last column must be added to the last two figures of the first column as shown in the example following:

594,686	594	686
352,843	352	843
793,925	793	925
1,741,454	1,739	2,454

1,739
2,454

39 + 2 = 41

So the result is 1,741,454. In this manner figures of any number of places may be added without mental calculation, it being only necessary to set down the slide-rule readings as shown in the foregoing examples.

Akron, Ohio. A. B. SOLOMON.

Alignment Charts for Finding the Dimensions and Volumes of Bumped Heads

In *Power* for June 17, 1919, on page 927, at the top of the second column, there appears the statement, "The larger value is what the mathematician would term an imaginary quantity, which for practical purposes has no significance." This statement is not correct, and should be changed to read as follows: "The larger value satisfies the mathematical conditions of the equation, but does not satisfy the physical conditions of the problem, and hence has no significance for practical purposes."

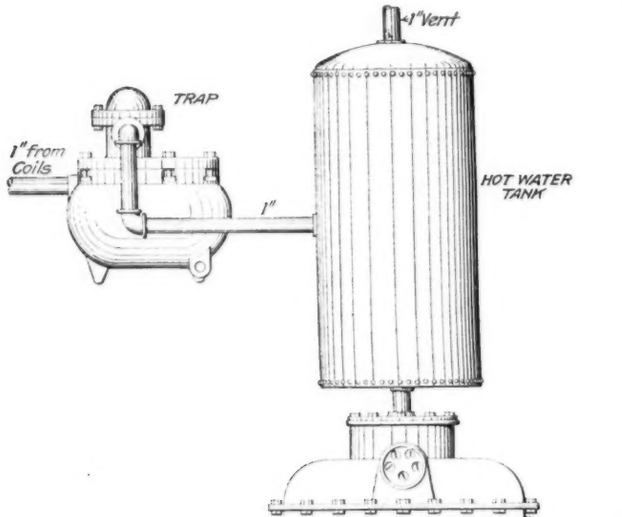
The larger value in question is in no sense an imaginary quantity, as was incorrectly stated.

Detroit, Mich. C. H. BERRY.

Metered the Condensation

In computing the amount of steam used by several of the tenants in the plant I was operating, I would at intervals open the return line and put a barrel on a set of scales under it, and by timing the flow and weighing it I figured the amount of steam condensed per hour. Multiplying this by the number of working hours, I got the approximate amount of steam for which to charge. In spite of the fact that I tried my best to weigh the condensation under average normal conditions, there was constant bickering and dispute about the amount charged.

Looking into the steam-flow meter data, I found that the lines were too small and the expense too great to warrant their use. With the idea of some day finding a satisfactory solution to the problem and always on the lookout for it, I finally found it in the shape of a condensation meter. The illustration shows the method I used in installing several of these meters with highly satisfactory results to all concerned, as I never had a



ARRANGEMENT FOR METERING CONDENSATE

question raised as to their accuracy after they were installed. The steam was used in pipe coils for heating and drying in manufacturing processes and was trapped and the condensation was discharged into the sewer, being too far away from the plant to warrant bringing the returns back.

The traps were of the bucket type, and as the meters are of a gravity flow, nonpressure type, I piped the discharge of the trap to a 12 x 24-in. expansion tank (the kind used in house hot-water heating systems) placing it above the meter, the water flowing from the tank to the meter by gravity. From the top of the expansion tank I piped a vent line running up about twenty feet and extending outdoors. At the discharge of the trap this line would relieve all pressure and yet not allow the condensation to escape.

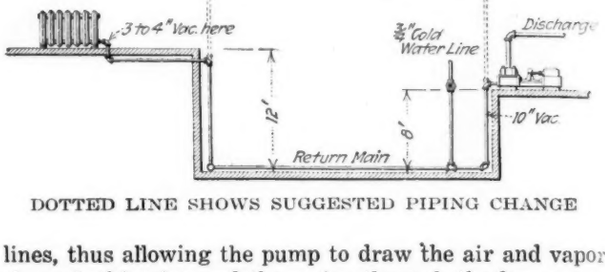
The water flowing through the meter into the drain was recorded in pounds on the dials of the meter and was read monthly, the same as gas or electric meters are read.

A. A. WAINRIGHT.

Philadelphia, Penn.

Heating-System Problem

Commenting on the heating-system problem of L. B. Shields, on page 867 of the June 3 issue, I would suggest that the system shown in his Fig. 1 could be improved by installing a connection at the elbow where the pipe dropped twelve feet and carrying it up to allow the necessary clearance and then over and down to the pump suction to avoid the trap, as shown by the dotted



DOTTED LINE SHOWS SUGGESTED PIPING CHANGE

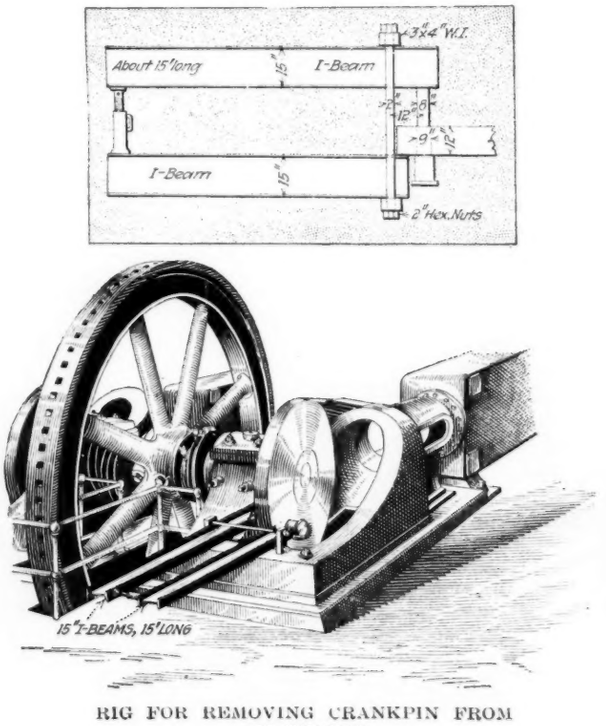
lines, thus allowing the pump to draw the air and vapor through this pipe and the water through the lower one, as shown herewith.

I believe this system would then work satisfactorily.

Brooklyn, N. Y W. T. MEINZER.

Rig for Removing a Crankpin

An engine crankpin 9 in. in diameter and 12 in. long worked loose, but a 400-lb. battering ram had no effect on it in so far as knocking it out was concerned. It was easily removed, however, with the application of the rig shown in the illustration. After its removal the



RIG FOR REMOVING CRANKPIN FROM AN ENGINE

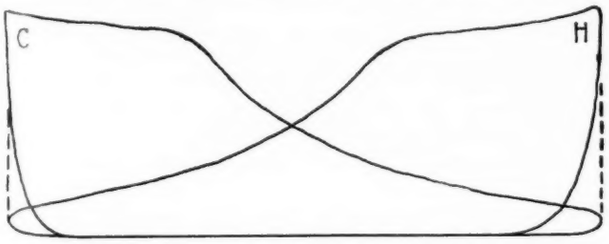
old pin was built up with a welder and turned down to size.

After heating the disk red hot with a coke fire, the pin was forced back in place. It has since been running satisfactorily for four or five months.

Norwood, Ohio. A. C. ROCKWELL.

Engine Crosshead Pounds

On page 827 of the May 27 issue of *Power*, E. Hollis shows an indicator diagram taken from his engine and says that the crosshead pounds. I believe the pound is due to lack of compression. The diagram shown herewith was taken from a 26 x 48-in. Corliss



ENGINE POUNDS WITH COMPRESSION AS SHOWN BY DOTTED LINES

engine, running at 74 r.p.m., boiler pressure 85 lb., 50 spring used. This engine runs quietly, but if I try to cut down the compression, as shown by the dotted lines, it pounds. Therefore, I think some compression would help Mr. Hollis. J. C. KAHL.

Columbus, Ohio.

Why Does One Seam Groove More Than Another?

In the July 8 issue of *Power*, page 75, A. Bennett shows two types of lap-riveted joints, one of which rarely if ever shows signs of grooving, whereas with the other type grooving is of frequent occurrence.

The shelf effect of joint *B* collects more or less moisture when the boiler is out of service and empty. This moisture generally being the result of condensation of some slight steam leak is practically chemically pure and a solvent, the result being that some slight corrosion starts which acts as an aid to cause grooving when the boiler is in regular service. In the other type of joint construction the shelf effect is on the outside of the boiler, and any moisture will run to the bottom of shell.

Still another cause of grooving might be due to the working of the joint caused by the expansion or contraction of the metal or by the alternate pressure conditions when the movement at the upper edge of the joint *B* would be greater by reason of its being closer to the horizontal center of the boiler, assuming, of course, that the greatest movement of the shell due to these causes is at the center. JOHN F. HURST.

Louisville, Ky.

Operating 125-Volt Motors on a 250-Volt Circuit

In a factory it was necessary recently to change the location of a machine used for spinning purposes. The machine was operated by two small 125-volt direct-current motors, connected to a 125- to 250-volt, three-wire system. The nature of the work was such that the motors operated simultaneously. In the new location of the machine a temporary wiring had been installed consisting of the 250-volt mains only. In order to prevent delay in the operation of the machine it was necessary to run the motors from the 250-volt circuit. They were connected in series across the circuit as shown in Fig. 1. When load was applied to the machine one of the motors would slow down and stop, causing the voltage of the other motor to increase to approximately 250 volts, resulting in excessive speed and heating of the motor. The connections were changed as shown in Fig. 2, in which a resistance *R* was used in series with each motor. The resistance was adjusted so that at full load the voltage across the motors would be just 125 volts. This proved objectionable, inasmuch as, when the load was taken off the machine, the voltage would increase to about 220 volts owing to the reduced drop across the resistance boxes. The connections were changed for the third time as indicated in Fig. 3. The two resistances across the line formed an artificial neutral. The motors operated properly this time, the voltage remaining constant at all degrees of load. The resistances were of course removed when the permanent wiring with the neutral brought out, was installed.

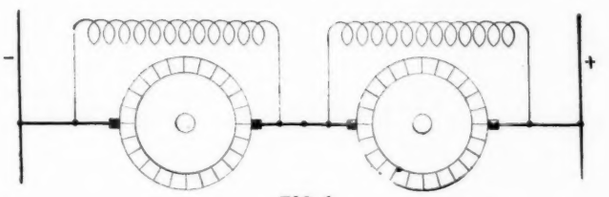


FIG. 1

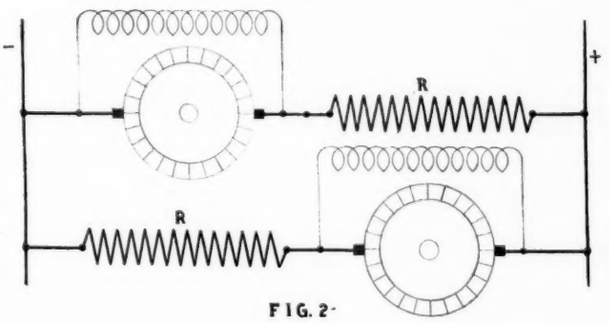


FIG. 2

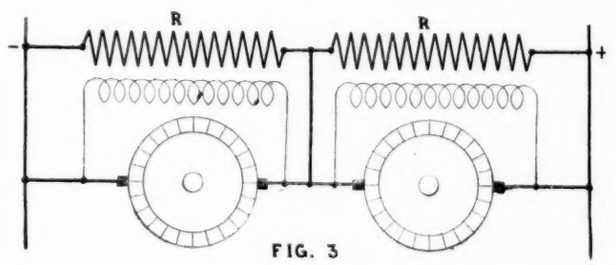


FIG. 3

FIGS. 1 TO 3. SCHEMATIC DIAGRAMS OF MOTOR AND RESISTANCE CONNECTIONS

Milwaukee, Wis. HOWARD D. MATTHEWS.

Why the Atmospheric Line?

Referring to the indicator diagrams submitted by M. J. Iles in the Aug. 12 issue of Power, page 269, I think he will locate his difficulty in getting the proper atmospheric line in his three-way cock. By taking this off I think he will find that the passage is choked when the handle is at either of the extreme points.

Corry, Penn. W. L. TRILL,
Trill Indicator Co.

Circulation in Water-tube Boilers

After reading the article in the June 3 issue of *Power*, page 855, by A. Bement, I wish to state that his ideas of the construction of both the furnace and the baffle plate in the steam drum are against the natural philosophy of boiler operation to produce the highest boiler efficiency and to obtain dry steam.

The horizontal and vertical baffle, as shown in his Fig. 2, applies all the furnace heat to the rear end of the tubes. The heat is deflected against the rear water-leg, and this forms a center of equilibrium of the water circulation, and from personal experiences, I find that the circulation is reversed and the water flows backward instead of forward.

As an illustration, assume that the distance from the water line in the drum to the bottom of the rear water-leg is 6 ft. and that the distance from the water line to the bottom of the front water-leg is 4 ft. 6 in. This allows a pitch of 18 in. to the tubes. Then suppose that the tubes are 16 ft. long, and adding this 16 ft. to the 4 ft. 6 in. gives about 20 ft. from the bottom of the rear water-leg to the water line just above the front water-leg. The distance from the bottom of the rear water-leg to the water line directly above it is 6 feet.

According to Mr. Bement's drawing, the furnace heat is applied to the rear of the tubes and to the rear water-leg. Naturally, the water will flow in the direction of the least resistance. This will be up through the rear water-leg into the drum. Applying the heat to the rear is the cause of retarding the circulation of the water in the right direction. Before the water can flow in either direction (because of the heat being applied to the center of equilibrium) a steam pocket must be formed to overbalance the pressure of the water in the drum. This, I find, is the cause of many burnt and blistered tubes. The furnace construction, as shown in Mr. Bement's drawings, also forms a soot and cinder pocket between the rear vertical baffle and the front water-leg, which prevents the heat units from being applied to the tubes.

I also find that an objection is made against a front vertical baffle, where the furnace heat is applied to the front end of the tubes passing in an upward direction, then downward and then upward again at the rear end, because of the smoke produced. In answer to this claim, I will state that, with the proper furnace construction under a vertically baffled boiler, it will produce less smoke than with a horizontal baffle and a higher steam-generating efficiency. The heat should be applied to the nearest point of release of the steam generated, which gives the least resistance of the upflowing mixture of steam and water and creates a rapid circulation, which is the main factor of steam-generating efficiency, and the prevention of burnt and blistered tubes.

In regard to the baffle or deflecting plate, as shown in the front end of the steam drum, it is not the right construction to obtain dry steam. The commotional contact of the upflowing mixture of water and steam with the main body of water in the drum will create a mixture of water with the outflowing steam, which is caused by having this deflecting plate in the wrong position.

In conclusion I wish to state that this baffle plate is a partial infringement upon my patented inventions.

Chicago, Ill. JOHN G. BROMAN, SR.

Superheated Steam—Why Not?

Referring to the editorial regarding superheated steam, in the July 1 issue, I wish to say that I have a fairly representative plant consisting of water-tube boilers carrying 160 lb. pressure, and superheating around 100 to 125 deg. in ordinary practice. I also have one 750-hp. cross-compound Corliss condensing engine driving a two-stage air compressor. This engine was designed for 125 lb., saturated steam, and trouble was anticipated in using the valves with superheated steam, but it did not materialize, as we experimented until a cylinder oil was obtained that would stand up under the service. Since that time no trouble has occurred.

A 450-hp. Unaflow engine was also designed for 125 lb. gage pressure and saturated steam. We had to do some fitting on this engine in order to operate with superheated steam. The first piston supplied with the engine wore down over $\frac{3}{16}$ in. the first year of running, so we put in a new one with a tail-rod and guide to help carry the weight. I do not know whether this will cure the trouble or not.

I also have a twin-tandem compound pump designed for 100 lb. saturated steam. These three engines operate practically continuously. Although this pump has been stopped an aggregate of but 36 hours in four years, it has given no trouble due to wear or because of faulty lubrication and has had only one ring of packing inserted in the stuffing-box in that time. The Unaflow engine, driving a direct-connected alternator, runs practically continuously, as does the air compresser.

For the first two years we examined the valves on these engines every two weeks and gaged the lubrication accordingly; since then they have been examined about every six months. A little trouble was encountered at the start, on account of using too light an oil, until we finally got a specially compounded oil to suit our temperature and moisture conditions. Right here I wish to say that superheated steam does not necessarily mean dry steam; I have considerable moisture in the steam, and it is not the result of condensation.

Besides the foregoing equipment, there is an old straight-line compressor with slide valve and an old slide-valve cross-compound two-stage compressor. These are used only as an emergency set. They give considerable trouble with regard to both packing and lubrication, but are not used enough to determine whether the trouble can be overcome or not.

In summing up, our experience with superheated steam in general has been that Corliss valves give very little trouble if properly fitted and mechanically lubricated. Hydrostatic lubricators are not suitable, and the oil must be properly compounded for temperature and moisture and introduced as close to the points of lubrication as possible, using a multifeed lubricator. Slide valves are not suited to superheat unless designed as light as possible and special oil grooves used to retain the oil. Engines should have deep stuffing-boxes, and metallic packing should be used where possible. I believe that the poppet-valve engine is the logical engine for superheated steam, but it is not necessarily the only one.

Of course results may be different with higher pressures and temperature, but these are my experiences with 150 lb. pressure and 125 deg. superheat.

Ringwood Manor, N. J. ALLAN A. BLANCHARD.

Inquiries of General Interest

Analyzer in Absorption System—What is the analyzer used in the absorption system of refrigeration and what are its functions? H. E. A.

The analyzer is a separator, consisting of a shell with trays or basins one under the other inside. The strong liquor from the liquid pump comes into the top of the shell and it falls on the boiling liquid below, the vapor passing upward. This vapor, which is strong, after leaving the analyzer passes through a rectifier on its way to the condenser. The rectifier aims to extract the last bit of moisture in the gas. The function of the analyzer, therefore, is to separate the ammonia gas from the water which it took up in the generator.

Ball Versus Disk Check Valves—What are the relative merits of ball and of disk check valves? H. D. Y.

The principal advantages of ball check valves are simplicity and compactness and durability for situations where leakage is not of serious importance. For a ball check to remain tight with use, the ball must continue in the form of a perfect sphere and the wear of the seat from pounding must shape the seat to the radius of the ball. The seat may continue round, but unless its surface conforms to the spherical form of the ball, contact between the valve and seat is reduced to a line and there is no breadth of seal against leakage. To obtain a good bearing surface for the seat and correct spherical form of ball requires a high order of mechanical skill. Disk valves tend to conform to their seats from use, they are readily repaired in place and therefore are preferable for situations where check valves must be tight and are accessible for repairs.

Fall of Potential Method of Measuring Resistance—In a well-known book it is stated that a known resistance and voltmeter are required to make electrical resistance measurements by the "Fall of Potential Method." While talking with one who is an authority on the subject, I was told that a voltmeter and an ammeter are required to measure ohmic resistance of electric circuits by the "Fall of Potential Method." Which method is the "Fall of Potential Method"? M. W. K.

Your question is one that is open to discussion. Although certain authors of books dealing with the subject use a voltmeter and a known resistance to measure the ohmic value of an unknown resistance and refer to it as the "Fall of Potential Method," in one of the electrical engineers' handbooks the statement is made, "The fall of potential method consists simply of noting the voltage drop with a known current flowing through the resistance, and calculating the resistance from Ohm's law $R = \frac{E}{I}$." Since the volts drop is used in both cases, it is apparent that both schemes are "Fall of Potential Methods." In one case a known resistance is used with the voltage drop, and in the other the current is used with the volts drop to obtain the ohmic value of the unknown resistance.

Trouble with Hand Rope of Elevator—We have considerable trouble from the hand rope on a freight elevator becoming too tight or too slack for use within an hour or two after the length has been adjusted, and find the rope has turned the swivel at the turnbuckle. What is the cause and remedy? E. P.

This trouble is common with wire hand ropes for operating elevators, especially where long ropes are required for elevators passing through a number of stories. Tightening and slackening of the rope is due to expansion and contraction of the wire from changes of temperature and swelling and shrinkage of the hemp core due to variable moisture of the atmosphere. For most situations the use of tightener pulleys for automatically preserving the tension would be impracticable and it is necessary to depend on hand adjustment of a turnbuckle. The bother occasioned by a slackened hand rope coming off the sheaves may be avoided by providing guards each side of the sheaves.

Feasibility of Using Air Lift—We use two duplex pumps for raising water from three driven wells that are 110 ft deep. The pumps are located in a pit that is about 10 ft. deep, but the water level in the wells is so low that the suction is 25 to 28 in. vacuum and there is considerable pump slippage. Would it not pay to install an air lift to raise the water to the pit and pump from the pit? G. H. D.

The conditions are favorable to use of an air lift and as it is quite evident that by pumping, the level of the well water drops beyond the suction lift of the pumps, the pumps must be lowered or some type of deep well pump should be installed. By submergence of air lifts within about 3 ft. of the bottoms of the wells, there would be fair air lift efficiency for delivery to the pump pit, and nearly as good efficiency if the air lifts discharge two or three feet above the surface of the ground.

Transformers Connected Delta and Star—Will three transformers connected delta have the same capacity if connected star? M. A. B.

When transformers are connected in delta as in Fig. 1, the current per terminal is 1.732 times the current per transformer and the voltage between terminals is that across each transformer, that is, if the current in each transformer winding is 100 amperes, the current per terminal will be $100 \times 1.732 = 173.2$, and if the volts across each winding is 1000, the pressure between terminals is

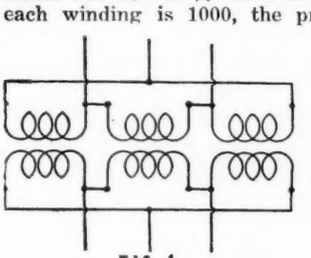


FIG. 1

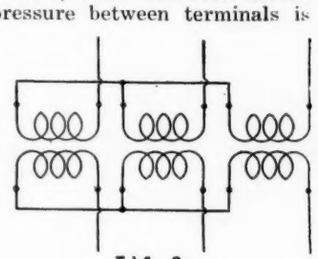


FIG. 2

also 1000. In the star connection, Fig. 2, the current per terminal is that per winding, but the voltage between terminals equals the volts per transformer times 1.732. In other words, if the current per winding is 100, the amperes per terminal will also be 100, against 173.2 for the delta connection. With 1000 volts across each transformer in the star connection, the volts between terminals will be $1000 \times 1.732 = 1732$, compared with 1000 for the delta connection. The total volt-amperes in each case equals volts $\times$ amperes $\times$ 1.732, which gives for the delta connection $1000 \times 173.2 \times 1.732 = 300{,}000$, and for the star connection $1732 \times 100 \times 1.732 = 300{,}000$, giving the same capacity in each case. However, it is evident that for this to be possible the volts applied to the star-connected bank of transformers must be 1.732 times as great as for the delta connected. A bank of three transformers connected delta and operating on a 6600-volt circuit will have the same capacity as the same bank connected star and operating on 11,000 volts, that is, $11{,}000 = 6600 \times 1.732$, approximately.

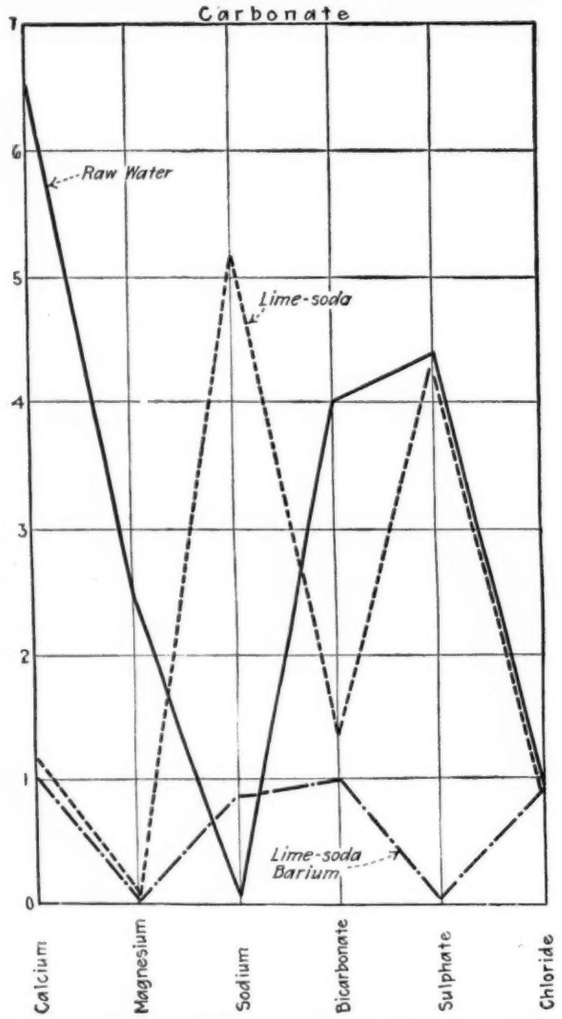
[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Softening Boiler-Feed Water*

By W. F. Monfort

It has been known since 1845 that the use of lime for softening certain waters gave excellent results. The later-developed use of soda ash with lime was a great advance. With some waters such treatment does all that can be desired, and it has followed that frequently only this treatment has been considered. The situation is like that when slow sand filters were installed in this country to purify very turbid waters, to which they were not adapted. The hope was strong, the principle unsound, the result disappointing.

The larger railway systems have found it advantageous to install water-treatment plants. Many industrial enterprises also use water softeners regularly and find economy in installations that take the strain from boilers, save coal at war prices and maintain expensive plants at high efficiency when labor and material are at a premium. But a larger number of small and medium-sized water and light plants are still using water without treatment. The adequate treatment of a boiler-feed water should be based on a complete analysis of the water; this should take place outside the boiler and should be tested by its results.



GRAPHIC REPRESENTATION OF WATER BEFORE AND AFTER TREATING

A proper analysis of a water can be expressed in terms of actual facts developed; it does not involve any hypothetical combinations, which are at best misleading, since no one knows and few will agree as to the probable combinations occurring in a water wherein most, if not all, of the chemical components are dissociated to a large extent. As an instance may be cited the varying statements of the analysis of a single water according to the scheme of combinations favored by several analysts and boiler-compound people. Most of them are based upon varying conceptions of what residue will be formed in a boiler as evaporation proceeds. Scale deposits in different parts of the ordinary boiler are not of fixed and invariable composition, and our knowledge is here incomplete. It is probable that the reactions differ in various parts of the same boiler at a given time, and that the full range of reactions is not given in the whole collection of combinations in Table I.

TABLE I. HYPOTHETICAL COMBINATIONS REPRESENTING ONE ANALYSIS

Parts per Million

	1	2	3	4	5	6	7
Silica	29	29	29	29	29	29	29
Iron oxide	..	..	..	0.7	..	0.7	0.7
Iron carbonate	1.6	1.6	1.6	..	1.6	..	..
Calcium bicarbonate	210	210	36	8	126	130	210
Calcium sulphate	..	..	147	147	68	68	..
Calcium chloride	..	..	..	19	..	..	..
Calcium nitrate	..	..	..	..	4	..	..
Magnesium bicarbonate	20	20	96	96	96	96	24
Magnesium sulphate	62	62	..	..	..	..	60
Sodium bicarbonate	..	..	94	128	..	..	..
Sodium sulphate	80	80	..	..	83	83	83
Sodium chloride	10	13	10	..	10	20	20
Sodium nitrate	4	..	4	..	..	..	..
Potassium chloride	12	9	12	..	12	..	..
Potassium nitrate	..	5	..	..	..	..	..
Sum	429	430	430	428	430	427	427
Scale-forming constituents	233	233	255	257	236	235	236
Foaming constituents	106	107	80	82	105	103	103

That the analysis should be complete is indicated by the variety of troubles in boiler-feed waters due to silica, sulphates, calcium and magnesium, bicarbonates, sodium and potassium, nitrates, iron, manganese and chlorides. Silica in some waters causes an abundant hard scale. Its treatment calls for special methods.

Sulphates in conjunction with calcium yield, on evaporation, a hard scale of calcium sulphate in some parts of the boiler. The common treatment is the addition of soda ash. If made to the feed water, there is a high concentration of sodium compounds in the boiler along with precipitated calcium carbonate, which combination favors foaming, wet steam, waste of packing and gaskets, and other ills. Even with pretreatment foaming may follow.

Calcium and magnesium in waters of high bicarbonate content yield a soft scale, abundant and wasteful of heat.

TABLE II. RESULTS OF SOFTENING OF THREE TYPES OF WATER

Dissolved Solids		Calcium	Magnesium	Sodium	Bicarbonate	Carbonate	Sulphate	Chloride
523	1—Raw	6.56	2.63	0.02	4.00	0	4.38	0.84
401	Soda-lime	1.2	0.1	5.22	0	1.3	4.38	8.84
99	Alternate	1.0	0	0.84	0	1	0	0.84
162	2—Raw	3.5	2.9	1.3	7.8	0	0.05	0.1
121	Lime-acid	0.6	0	1.3	0	0.6	1.2	0.1
1277	3—Raw	2.6	1.33	1.56	2.91	0	2.16	0.34
222	Soda-lime	0.9	0.1	2.50	0	1	2.16	0.34
158	Alternate	0.9	0.1	1.66	0	1	1.23	0.34

Cost of Treatment, Cents per 1000 Ga.

1—Soda-lime	3.42
Alternate	15.38
2—Lime-sulphuric acid	1.09
3—Soda-lime	0.89
Alternate	4.27

It is difficult to prevent pitting and corrosion of rivets, seams and plates when the deposited soft scale interferes with quick transmission of heat. If precipitated and collected before the feed water is introduced into the boiler, the economy is great. Corrosion is promoted by deposit of those magnesium salts which decompose with the liberation of acids (magnesium, chloride, sulphate, nitrate) and such excesses of carbonic acid as are frequent in many waters.

How the nature of a water and the results of treatment may be shown is illustrated in the accompanying graphic representation of a water before and after treatment. Before treatment it was high in calcium and sulphates, forming hard scale, but low in other constituents; with soda ash and lime the sodium content was increased and foaming

*Excerpt from paper on "Present Tendencies in Water Purification," presented before the Missouri Association of Public Utilities.

resulted. Using another treatment, lime soda ash and a barium compound, it was possible to render this a desirable soft water containing little more than one pound dissolved matter per thousand gallons, causing neither hard scale nor foaming.

Treatment must be adapted to the individual supply; and this is one of the reasons for neglect. At the present time the high cost of coal makes water treatment well-nigh imperative. With well supplies of practically constant composition, maintenance of a successful softening plant, once installed, offers no difficulty. With surface supplies some additional supervision is required, but first cost and operation would be more than offset by boiler economies.

Another type of water, common in parts of Illinois, is represented in the analyses in Table II, representing the water before and after treatment with lime and sulphuric acid. The figures given are on the same scale as those in the former instance cited. Silica in this case is not an appreciable factor and is suppressed with other unessentials as before. A third is an average sample from the Missouri River near its mouth; two kinds of treatment are applied, with the results indicated.

In the table the cost data offered are based on before-the-war prices; present costs are uncertain, because of the downward tendency that should appear soon. Even allowing for lime at twice the former price, with soda ash at the double price and other reagents at current prices, the cost would not be more than doubled. There is still room for economy with the present prices for coal.

Summarizing the knowledge of water purification for city supplies has grown to an art within less than a century and has led to a satisfactory improvement in the quality of drinking water furnished to cities large and small.

Purification of boiler-feed waters has developed, but practical application has been far less general. The economies growing out of this knowledge, applicable in water and light plants generally, may well find more extended use at this time, when revenues are seriously impaired.

Feed water should be treated and clarified before it enters the boilers. Treatment should be determined after a complete analysis, which should be so expressed as to give the actual facts without the admixture of guesses.

Hays School of Combustion

A correspondence course in combustion—something the United States Fuel Administration had in contemplation before its services were suddenly curtailed—is now ready for prospective students. The author is Joseph W. Hays, with whom many engineers are already acquainted or at least familiar with his writings. Besides writing all books belonging to the course, Mr. Hays will supervise examinations and educational matters. The school has a staff of reviewing and advisory editors, consisting of David Moffat Myers, formerly advisory engineer for the Fuel Administration; Joseph Harrington of Chicago, an authority on combustion; Fred R. Low, editor of *Power;* Arthur L. Rice, editor of *Power Plant Engineering;* and Prof. S. W. Parr, chemist, University of Illinois. This staff reviews and passes upon all manuscript prepared for the course. The commercial end of financing and operating the Hays School of Combustion has been undertaken by R. C. Acers, president; L. C. Petitt, vice-president and treasurer, and H. R. Newlean, secretary. General offices are located in the State-Lake Building, Chicago, Ill.

From the prospectus and from the knowledge that it will be prepared and supervised by a noted educational staff, the course should prove of interest and value to all men interested in the production or use of power. It is especially commended to chief engineers and firemen of stationary and locomotive boilers, plant owners and managers, shop engineers, mine operators, electrical engineers, erectors of boiler-room equipment, salesmen of power-plant apparatus and of coal, and in fact any man concerned in keeping fuel costs down and fuel efficiency up, whether he be employer, employee or advisor.

Fuel conservation is one of the vital problems of the day. Coal prices are high and the saving of fuel means more than it did years ago. The remedy for fuel waste is a thorough knowledge of combustion and the initiative to apply that knowledge in everyday boiler-room operation. What is needed is men trained to the requirements of economical operation by men who have had years of practical experience. There is a scarcity of good combustion engineers, and to the right men the possibilities are promising. Due to existing conditions a knowledge of combustion is vital and this applies to the operator and all concerned.

In the Hays School the idea is to give the training in the shortest and simplest form possible and in concise language that can be understood without previous technical training. The plan is to sell service—not a set of books—with the object of turning out good combustion engineers.

The course consists of twelve instruction books, each separately bound. With the first instruction book the student receives a permanent cover in buckram, into which is inserted each succeeding book as it is received. The student's progress is determined by examination questions accompanying each book, which are designed to test his knowledge as to details and general principles. When a satisfactory grade has been passed, he receives the next book and, after satisfactorily completing the course, is entitled to the Hays Diploma, which serves as an assurance that the holder is a capable combustion engineer. Still the school is not through with the student. Through its service department it will endeavor to place him gratis in a favorable position. If he is already employed in a power plant, the employer (unless the student otherwise specifies) will be notified as soon as his employee takes up the course. He will be kept informed of the student's progress, and at the same time the student will be sent definite suggestions on how to demonstrate to his employer the money-saving value of his increased knowledge, such procedure being designed to improve the position of the student and increase his salary. An outline of the course follows:

Book 1: Introductory chapter, history of steam, etc.

Book 2: Boiler furnaces and general rules of practice.

Book 3: General discussion of drafts—natural and artificial.

Book 4: Natural fuels and all about them, including methods of coal, oil and water analysis.

Book 5: Physics and the chemistry of combustion. Combustion analysis.

Book 6: Operation of boiler plants with manufacturers' illustrations of boilers and other apparatus. Applied combustion analysis.

Book 7: Smokeless combustion. Applied combustion analysis.

Book 8: Boiler and furnace testing. Applied combustion analysis.

Book 9: Dealing in detail with such important specific matters as cannot be properly covered in the preceding instruction books.

Book 10: Industrial gases and the gas producer.

Book 11: Gas and oil engines.

Book 12: The combustion engineer and his work. Keeping charts and cost figures.

Frank W. Townsend

Frank W. Townsend, for thirteen years chief engineer of the Narragansett Electric Lighting Co., Providence, R. I., died at Saranac Lake, N. Y., Aug. 17, after a lingering illness.

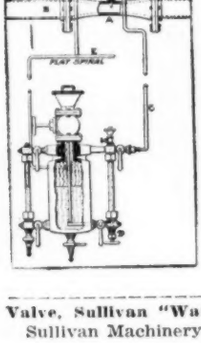
Mr. Townsend laid the foundation for his technical work by starting in the machine shop. He attended night school and studied hard the few engineering textbooks that came his way, later accepting a job in a shop doing marine work. From there to the engine room of an ocean-going steamer was but a step. He was connected for several years with the Clyde Steamship Co. and other Atlantic lines.

Returning to shore work, Mr. Townsend found for himself a responsible berth in the power-plant industry, eventually receiving the appointment as chief engineer in the 80,000-kw. turbine plant of the Narragansett company. He was 45 years old at the time of his death and had been in failing health for over a year.

Condensed-Clipping Index of Equipment

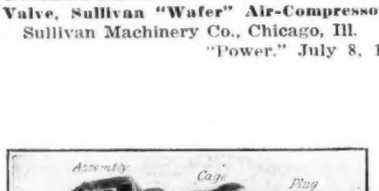
Clip, paste on 3 x 5-in. cards and file as desired

Lubricator, Meyeringh Proportional
Oil Well Supply Co., Pittsburgh, Penn.
"Power," July 15, 1919



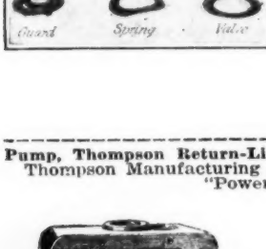
The proportional lubricator feeds oil to a steam line automatically and keeps the quantity of oil fed proportional to the steam flow through the line. It consists of an oil reservoir, condensing pipe and nozzle. The difference in gage pressure between the full area of the steam pipe and the contracted area of the nozzle is such that the quantity of oil flowing through the regulating valve will be proportional to the quantity of steam flowing through the steam line. The advantage of this device is that it can be installed in a steam line feeding one or more pumps or engines at the same time.

Valve, Sullivan "Wafer" Air-Compressor
Sullivan Machinery Co., Chicago, Ill.
"Power," July 8, 1919



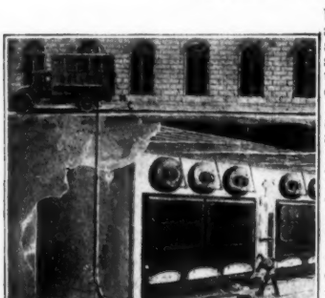
These valves are held to their seats by flat annular steel springs. They open against guard plates which give a wide port opening with a minimum of clearance volume. The valve spring and guards are accessible by removing a screw plug. The valves can be located close to the bore of the cylinder, thus keeping down clearance losses. When the valve is raised and the unloader is in action, no air is compressed.

Pump, Thompson Return-Line Vacuum
Thompson Manufacturing Co., Des Moines, Iowa.
"Power," July 15, 1919



This pump has but three moving members—the crank, the impeller, and the hinged plate. The last separates the suction and the discharge side of the pump cylinder. The impeller and pump casings are cylindrical, and the impeller is at no time in contact with the casing. Shaft is fitted with ball bearings. As the crank turns in a clockwise direction, it gives the impeller an eccentric motion; as the water enters the inlet pipe, it discharges into the space between the rotor and the casing, and as the rotor revolves, this water is carried around until it escapes through the discharge pipe.

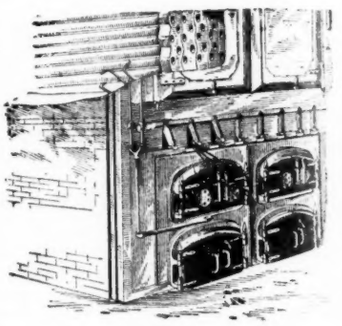
Ash Conveying, Pneumatic
Ash Removal, Inc., 347 Madison Ave., New York City.
"Power," July 15, 1919



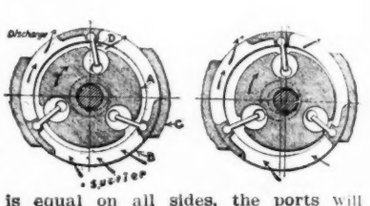
A 3 x 3 ft. concrete pit is built in front of the boilers and covered with sectional sheet iron, making it possible to uncover any section of the pit. An 8-in. conveying line extends from beneath the concrete pit to a point under the sidewalk at the curb. Intakes are inserted in the conveyor line at convenient points. A 6-ton capacity conveyor truck, equipped with a high-pressure blower and driven by the truck motor connects with the outlet of the conveyor pipe and the ashes are drawn into it and then discharged into a dump truck for carting away. The conveyor pipe is sold to the plant owner, but a charge is made for disposal of ashes.

Scraping Device, C. E. C. Tube
Combustion Engineering Corporation, 11 Broadway, New York City.
"Power," July 15, 1919

Openings are provided in the front and rear walls of a boiler setting, through which a light hook may be used for scraping the cinder from the bottom and sides of the lower row of tubes. The scraping wall boxes are made in sections with three, four and five doors, and are spaced the same distance apart as the boiler tubes. The openings, however, are placed halfway between the tubes so that the sides of the tubes may be reached, as well as the bottom, and also the bottom of the second row of tubes. The boxes are protected from radiant heat, and are fitted with cast-iron swinging doors or covers.



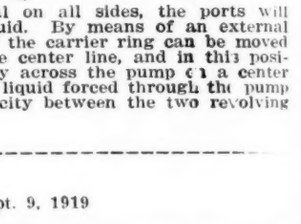
Pump, Ey-Pres Oil
D. H. McCorkle Manufacturing Co., Oakland, Cal.
"Power," Sept. 9, 1919



This pump is of the variable capacity, constant speed and constant pressure type. It consists of synchronously rotating two engaged bodies of different diameter on different centers. In operation the center of the rotor and the center of the rotating carrier arrangement are concentric, and as the displacement is equal on all sides, the ports will rotate without displacing any liquid. By means of an external adjusting handwheel the center of the carrier ring can be moved in a horizontal direction along the center line, and in this position the displacement diametrically across the pump on a center line is unequal and the volume of liquid forced through the pump depends on the degree of eccentricity between the two revolving parts.

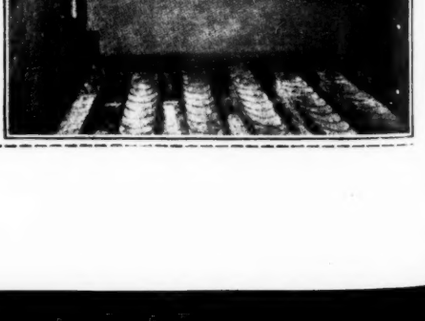
Valve "Adjusto" Generator
The W. M. Powell Co.
"Power," Sept. 9, 1919

The "Adjusto" generator valve for use with gasoline engines is of the throttling type with a needle-valve adjustment attached. This throttling feature enables the operator to regulate the engine speed and eliminate the ordinary butterfly valve. The gasoline supply is controlled by the needle valve, which is held to its adjustment by a curved spring and engages the knurled edge of the regulating wheel. Numbers on the wheel show the various degrees of openings. The gasoline connections are ⅛ or ¼ in. female iron pipe. The generator valve is especially adapted for marine engines, either two- or four-cycle types.



Arch, Liptak Double Suspension
Liptak Fire-Brick Arch Co., 844 Builders' Exchange, Minneapolis, Minn.
"Power," July 22, 1919

The distinguishing characteristic of this arch is that it is of a suspension design, consisting of a reserve arch over and supporting the lower arch that is exposed to the fire. The lower arch can be burned away without necessitating a shutdown, as the reserve arch protects the cast-iron supporting beam. Each beam is equipped with a replacement tip so that if the end blocks spread away exposing and damaging the supporting members, it will be necessary to replace the tip only.



Patented Aug. 20, 1918

Automotive Fuel Situation Discussed

Prominent executives and technical representatives of the automotive and fuel industries met at the University Club, New York, on the evening of Aug. 21 to discuss problems relating to the nature and future supply of fuel suitable for automotive purposes, and ways and means for utilizing this supply most efficiently and satisfactorily in the automobiles and other automotive vehicles now in the hands of users, as well as in those of vehicles to be constructed in very large quantities in the future.

In the absence of Charles F. Kettering, past-president of the Society of Automotive Engineers, and its official representative on the Automotive Conference Committee, C. F. Clarkson, general manager of the Society of Automotive Engineers, read a statement in which Mr. Kettering said in part:

"The fuel problem as it exists today divides into two general classes, one of which belongs to the automotive manufacturers and the other to the fuel manufacturers. However, a complete solution in either case is impossible without the hearty coöperation of both industries." Mr. Kettering then outlined in a general way some of the research work bearing upon the fuel problem which has been conducted in his own laboratories. In general the statement was to the effect that much basic research is still necessary to determine just what phenomena occur during the combustion of fuel in the engine cylinder, but that the research to date appears to indicate that a further study of the problems will enable a satisfactory engine fuel to be produced even though it becomes necessary, as seems most likely, to cut still deeper into the crude than is now common practice.

The subject of fuel specifications was discussed at some length and it was decided that a fixed specification would be detrimental to both producer and consumer, but that a flexible specification which would be changed from time to time as the exigencies of the fuel supply and demand may dictate would be useful to all concerned and a great assistance to the automotive manufacturer in enabling him to design his product in such way as to utilize the fuel most satisfactorily.

It was generally agreed that the numerous problems involved in a satisfactory settlement of the situation, rendered thoroughgoing and extensive research work very necessary, and that the representatives of the automotive industry would outline in considerable detail the various difficulties which the automotive engineer and car user faces in the use of present-day gasoline. An endeavor would be made to state clearly the fuel problem as it appears to the automotive industry for the purpose of aiding the fuel industry to prepare to meet the problem, so far as this can be done by the refiners. In addition, the representatives of the automotive industry indicated a desire to adapt the apparatus produced by them to the fuel which the petroleum industry, faced on the one hand by the increasing demand, and on the other by a diminishing supply of crude, can produce.

Aims of the Geographic Sections of the N. E. L. A.

In response to a request for his ideas regarding the scope and objects of the Geographic Sections, which are being enlarged, as discussed at the 42nd annual convention held at Atlantic City, N. J., May 20-24, 1919, President R. H. Ballard of the National Electric Light Association transmitted to President Thomas Sproule of the Pennsylvania Electrical Association, which convened at Bedford Springs, Penn., Sept. 4, the following in communication form:

In the Geographic Section we provide the electrical industry with the intermediating link between the central station, which is the unit of activity in which ideas naturally germinate, and the National Electric Light Association, which is transcontinental in its policies and its aims.

The greatest opportunity is offered for personal contact and interchange of ideas between executives and employees of the companies and all others interested in the electrical industry within the territory where conditions are frequently identical and unusually similar.

The results of progress made and new ideas demonstrated by one company, may be quickly conveyed to other companies in the same territory.

Opportunity is afforded men to think in broader terms and to apply their reasoning along sectional lines. This is the logical sequence of development—company to section; section to nation. The natural foundation for this line of progress is the company section, and its importance is inestimable.

The maximum opportunity is presented for cementing all branches of the industry into one harmonious whole; of increasing the sphere of influence exercised by those engaged in our profession, and in eventually creating a better understanding between the public served and those whose duty it is to serve the public.

In the Geographic Section a complete understanding should be reached between central stations, manufacturers, jobbers and contractor-dealers, as to the rightful place in the industry occupied by each group and in establishing the relations of one branch of the industry to the others.

In the Geographic Section we have a place where misunderstandings, friction, petty jealousies and fancied injuries can be ironed out and adjusted by bringing about a full and complete realization by all members of the section of the responsibility of service to the public and the joy of working out practical accomplishments of the ideal.

In the Geographic Section can best be worked out a definite plan by which the public may be kept informed on the true status of utility service in the district served.

In the Geographic Section there is ample opportunity for constructive initiative, and the opportunities for its exercise could be amplified indefinitely, the scope of achievement having no limitation but brains and ability.

We have the medium of crystallization; demonstrated and applying locally when local, and making universal when universal, all of the constructive creative forces that exist in the minds of the great membership of the National Electric Light Association.

Thirteenth Annual Convention of the A. I. S. E. E.

With the Hotel Statler in St. Louis as headquarters, the Association of Iron and Steel Electrical Engineers will hold its 13th annual convention Sept. 22-26. A tentative program has been prepared and contains the following:

Standardization Committee report, by T. E. Tynes, chairman; Educational Committee report, by A. B. Holcomb chairman; Safety Committee report, by Walter Greenwood, chairman; Electric Furnace Committee report, by Ralph D. Nye, chairman.

"Organization of the Electrical Department in the Steel Industry," joint paper; "Organization of the Operating Force," by H. C. Cronk; "Electrical Repair Shop," by C. A. Menk; "Storeroom and Spares," by T. E. Tynes; "Educational Training for Electrical Employees," by B. A. Cornwell; "Operation and Inspection," by A. Morgan and J. J. Booth; "Records and Testing," by R. B. Gerhardt; "Alternating Current Versus Direct Current for Table Motor Drive," by W. S. Hall; "High-Speed Motors with Herringbone Gears Versus Slow-Speed Motors," by J. E. Fries; "High-Temperature Furnaces," by C. A. Winder; "Meter Equipments in Steel Mills," by Paul M. Lincoln.

General discussion on the following topics: "Overload Protection on Cranes," by A. G. Place; "Crane Controllers," by James Maloney; "Motor Starters," by Walter C. Kennedy; "Design, Operation and Upkeep of Lifting Magnets," by James Farrington; "Recent Improvements in Industrial Control," by H. D. James; "Present Status of Arc Welding in the Steel Industry," joint paper by A. Churchwarden, of the Wilson Welder and Metals Co., H. L. Unland of the General Electric Co., A. M. Bennett of the C. & C. Electric Arc Welding Co., R. E. Kinkead of the Lincoln Electric Co., a representative of the Electric Arc Cutting and Welding Co., C. B. Waters of the Arcweld Corporation and A. M. Candy of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn.

What is said to be the largest airplane engine in the world was recently put under its first test in England. It is reported to be of 1000 nominal horsepower and to develop about 900 hp. at normal working speeds.

Inspection and Life Tests of Incandescent Lamps

The total number of lamps offered for delivery to the Government purchasing authorities during the past fiscal year was over 5,000,000, of which about 600,000 were rejected on the initial inspection at the factory, which covers the mechanical qualities of the lamps and their rating in regard to power consumption and efficiency. In this initial inspection samples are selected for the burning or so-called lift tests. During the year nearly 3500 lamps were subjected to this life test, and with few exceptions the tungsten lamps, both vacuum and gas-filled, supplied under Government contracts, had a life considerably in excess of the 1000 hours of burning required by the standard specifications.

At the request of the General Supply Committee, tests were made in connection with bids of various manufacturers for the contract for the next fiscal year, and a considerable range in quality among the lamps submitted was indicated. It is probable that the information obtained by these tests alone repays the total cost of lamp work for the year.—*Commerce Reports.*

Public-utility generating plants of this country during March produced 1,300,924,000 kw.-hr. generated by water power and 1,842,214,000 kw.-hr. generated by the use of fuel, making a combined total 3,143,138,000 kw.-hr. Figures have been compiled by Division of Power Resources, United States Geological Survey, and embrace approximately 89 per cent. of the plants throughout the country. New York leads in amount of electric energy produced, showing the largest amount of current generated both by water power and by fuel plants. New York state manufactured 222,318,000 kw.-hr. by water power and 228,191,000 kw.-hr. by fuel plants. California is next in the generation of power by water, with a total of 215,914,000 kw.-hr., but Pennsylvania has the second largest output, showing the largest output generated by fuel next to New York. Pennsylvania produced 62,509,000 kw.-hr. by water power and 246,989,000 kw.-hr. by fuel.

Domestic Exports of Air-Compressing Machinery

The following statement issued by the Bureau of Foreign and Domestic Commerce shows the domestic exports of air compressing machinery during June of this year:

Countries:	Dollars	Countries:	Dollar
Belgium	15,257	Argentina	10,891
France	128,971	Brazil	20,141
Italy	79,415	Chile	2,497
Netherlands	5,892	Peru	857
Norway	4,709	Uruguay	700
Russia in Europe	6,750	Venezuela	2,250
Spain	74,644	China	323
Sweden	1,446	British India	5,018
England	43,401	Dutch East Indies	3,175
Scotland	1,441	French East Indies	7,341
Canada	40,405	Japan	68,992
Costa Rica	18	Australia	5,593
Panama	1,166	New Zealand	450
Mexico	12,373	Philippine Islands	6,731
Miquelon, Langley, etc.	1,000	British South Africa	3,270
Newfoundland and Labrador	112	Portuguese Africa	132
Cuba	20,419		
Dominion Republic	90	Total	575,870

The Board of Standards and Appeals of New York City held a public hearing Sept. 3 on a tentative draft of amendments of rules governing the storage and use of fuel oil and the construction and installation of oil-burning equipment. The hearing was attended by representatives of the American Society of Liquid Fuel Engineers, leading oil companies and many manufacturers of oil-burning equipment. The information presented was taken under consideration by the board and there will be another public hearing on Wednesday, Sept. 17, at 10 a.m., in room 919, Municipal Building. It is expected that copies of the amended draft of rules for consideration on the 17th inst. will be available for distribution on and after Sept. 11.

The results of the present lack of transportation in China are shown by the fact that, while the cost of mining coal at Siwan, in Kwangsi, is reported to be about $1 a ton, the expense of moving it to Canton is about $11 a ton. Since the coal is not of high grade, it cannot compete with coal imported from other places by sea, and so the mines have been closed and the expensive machinery is idle. The tin mines at this place are a continuation of the deposits in Hunan, but are not even mapped.—*Commerce Reports.*

Personals

W. C. Tyler, New York district manager for the Poole Engineering Co., Baltimore, has been appointed general sales manager.

Charles W. McKay, author and technical writer of industrial subjects, has taken charge of the appraisal division of L. V. Estes, Inc., Chicago, Ill.

Tell Berna, formerly district manager for the Cutler-Hammer Manufacturing Co., Cincinnati, Ohio, has become associated with the G. A. Gray Co., of same city, as sales engineer.

Edward R. Cardinal, formerly district sales manager for the Carpenter Steel Co., and until recently president of the Cardinal Tool Co., of Philadelphia, has been appointed district sales manager of the Tacony Steel Co., Tacony, Philadelphia.

Charles E. Gradwell, of Gradwell & Phelis, Birmingham, England, agents for the Hofmann-Sproul Co., of Philadelphia, has sailed for home. After placing certain contracts in England Mr. Gradwell will leave for China, where he has been appointed special buyer of scrap for the Hofmann-Sproul Co.

E. L. Sullivan, who has been connected with the McDonough Regulator Co. for the last ten years, has been appointed to represent the Green Engineering Co., of East Chicago, Ind., at 2545 Oliver Building, Pittsburgh, his district to include western Pennsylvania, eastern Ohio and western West Virginia.

Herbert C. Hoover is expected to arrive in American about the middle of September. The engineers of America, under the auspices of the American Institute of Mining and Metallurgical Engineers, have decided to express their admiration for Mr. Hoover's services in international affairs during the war by giving him a banquet, to be held in New York, shortly after his arrival.

Harry M. Giles has been appointed general superintendent of the South Philadelphia Works of the Westinghouse Electric and Manufacturing Co. Mr. Giles, who succeeds the late Oscar Otto, killed in an automobile accident last month, has risen from the ranks in the Westinghouse organization. For a number of years he has been superintendent of marine erection, a position to which he was appointed by H. T. Herr, when the electric company absorbed the machine company.

Engineering Affairs

The National Electric Light Association, New England Section, will hold its annual convention at the Hotel Griswold, New London, Conn., Sept. 16-18.

The National Safety Council will hold its eighth annual safety congress at the Hotel Statler, Cleveland, Ohio, Oct. 1-4. Exhibits will be at Gray's Armory.

Miscellaneous News

The Division of Operations of the United States Shipping Board announces that the Board has awarded to the Mexican Petroleum Corporation the contract for 500,000 bbl. of grade "C" oil fuel to be taken in cargo lots during the next twelve months. The price is $1.18 per barrel. The point of delivery is the United States Shipping Board bunkering station at St. Thomas, W. I.

San Joaquin Light and Power Co., Fresno, Calif., has let contracts amounting to over $1,000,000 for machinery and equipment to be installed in the new Kerckhoff power plant. Three 15,000-hp. turbines with generators will be installed.

The Electrical Exposition, which has been held in New York annually since 1907, excepting last year, will be held this year at Grand Central Palace, beginning Sept. 24 and lasting ten days. This year's show will be especially varied and interesting because it will disclose high-tension developments in the electrical field for the last couple of years.

The War Department is offering for sale the town of Nitro, W. Va., a complete industrial comunity embracing 737 manufacturing buildings, housing accommodations for 20,000 people, and the utilities and civic improvements that constitute the conveniences of a modern city. Nitro, built by the Government at a cost of approximately $70,000,000, is the site of the second largest smokeless-powder plant in the world. The bids will be opened at noon, Sept. 30, 1919, at the office of the chairman of the Ordnance District Salvage Board, 1710 Market St., Philadelphia, Penn.

The Stoker Manufacturers' Association will hold its fal meeting at French Lick, Ind., on Nov. 3-5. This organization has had several important committees in session during the year, and interesting reports of the stoker situation throughout the country will be presented at that meting. S. L. Nicholson, assistant to the vice president of the Westinghouse Electric and Manufacturing Co., is expected to have some very interesting remarks to make on the future of business in the country.

Business Items

The **C. A. Willmarth Co.** has moved its office to Chelsea, Mich., where its plant, with latest improved machinery and process for making peat fuel, is nearly completed.

The **Busch-Sulzer Bros. Diesel Engine Co.**, St. Louis, Mo., has opened an Eastern sales office at 60 Broadway, New York City, in charge of George D. Pogue, with Stanley Wright as assistant.

The **American Steam Conveyor Corp.**, Chicago, announces the appointment of Morton McI. Dukehart & Co., as its representative in Baltimore and the surrounding territory, which includes all of Maryland, the District of Columbia and a few counties in Pennsylvania, Delaware, West Virginia and Virginia.

The **Sullivan Machinery Co.** announces the appointment of R. S. Weiner as district manager at El Paso, Texas, succeeding Don M. Sutor. Mr. Sutor has been transferred to the company's St. Louis office as district manager for Missouri, Eastern Texas, Oklahoma, Kansas, Western Kentucky and Western Tennessee.

Frank D. Chase, Inc., Industrial Engineers, Chicago, are preparing plans for a new heating plant to be erected for the Samson Tractor plant at Janesville, Wis. The first unit will have a capacity of 2000 hp. It will be equipped with Stirling boilers and Taylor stokers. Coal will be stored in an inclosed building. It is delivered to the bunkers above the stokers through a track hopper, crusher and elevating system. The ashes also will be removed by mechanical means, and a crane will be installed to handle both the coal and ashes in an emergency, as well as for handling of storage coal to the track hopper. This first unit will serve buildings now erected or under construction for the Samson plant, and will be doubled as the plant increases.

Trade Catalogs

The Earle Gear and Machine Co., Philadelphia, Penn., has issued a new catalog fully illustrating and describing Earle centrifugal pumps. Copy free upon request.

The Under-Feed Stoker Co. of America has recently issued a 32-page catalog, nicely printed, which completely illustrates and describes the Jones "Standard" stoker.

The United Stokers Corp., Chicago, Ill., has issued a 7-page bulletin, No. 101, descriptive of Simplex conveyors for soot, dust and combustion ash. Copy free upon request.

The A. Y. McDonald Manufacturing Co., Dubuque, Iowa, has just issued its 53-page catalog No. 5 on "Oil Specials." Loading and unloading apparatus, swing joints, hand and power pumps, tank valves, and all such equipment for handling gasoline, kerosene and other liquid petroleum products are shown and described.

The Breeze Manufacturing Co., Newark, N. J., has issued a 34-page catalog on "Flexible Metal Hose-Tubing and Accessories." It illustrates and covers metal hose in detail for every type and method of winding, how it is applied and why, and what industries use it. It is the only booklet of its kind published in this trade. A copy may be had free upon request.

The Bonnot Co., Canton, Ohio, has just issued a 135-page catalog on "Holbeck Pulverized Coal Systems." It is an up-to-date book on the subject and contains much useful information for executives and engineers. It is copiously illustrated; several perspective views of complete coal storage and pulverized coal plants are shown, as well as various installations, processes, etc.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has published an interesting, descriptive little bulletin (No. 138) entitled "Prospectus of Apprenticeship System," which intends to convey to the boy who is ambitious, desirous of obtaining a degree or learning a trade, the method by which his ambitions may be realized. The Allis-Chalmers Manufacturing Co., which builds everything in stationary power units, offers exceptional opportunities for learning trades, and its co-operative course is open to the boy who shows talent along mechanical lines as well as to the young man who has completed high school and then wishes to obtain a degree. A copy of the bulletin may be had free upon request.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.60@3.10	$3.00@3.60
F. o. b. Philadelphia, gross tons	4.79@5.35	5.20@5.80
F. o. b. New York, gross tons	5.10@5.70	5.50@6.20
Alongside Boston (water coal), gross tons	6.85@7.35	7.10@7.85

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6.25@6.60 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.30	$7.05
Egg	6.35	8.20	Buckwheat	3.40	5.15
Stove	6.60	8.45	Rice	2.75	4.50
Chestnut	6.70	8.55	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.70@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@2.90
Reynoldsville	2.70@2.90
Quemahoning	3.25@3.50
Somerset (best)	3.00@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.50@2.75
Fairmont	2.35@2.50
Latrobe	2.60@2.65
Greensburg	2.50@2.60
Westmoreland ¾ in.	3.50@3.75
Westmoreland run-of-mine	3.20@3.35

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Anthracite Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.35	8.20	Rice	2.75	3.65
Stove	6.60	8.45	Boiler	2.50	3.50
Nut	6.70	8.55	Barley	2.25	3.15
Pea	5.30	6.90			

Illinois

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@ 2.50	3.00
Screenings	1.40@ 1.60	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.25	$2.60	$2.40
Black Creek and Cahaba	3.25	3.45	3.05
Jagger - Pratt Corona	2.85	3.00	2.45
Blacksmith	....	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	5.00@$5.50
Corona	3.50
Jagger	3.50
Montvallo	5.50@$6.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.85*@3.05	$2.55 $2.25@2.50
Mine run	2.10*@2.35	2.35 1.60@1.70
Screenings	1.50*@2.20	2.05 .90@1.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1.07½; other rates $0.92½.

New Construction

PROPOSED WORK

N. H., Portsmouth—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until September 17, for the installation of a 100 kw. turbo generator, here. Estimated cost, $17,000. Noted August 26.

Conn., New Britain—Landers, Frary & Clark, Commercial St., are having plans prepared for the construction of a 6 story, 80 x 160 ft. and 50 x 160 ft. factory, on Center St. A steam heating system will be installed in same. Total estimated cost, $150,000. Max J. Unkelbach, 162 Main St., Arch.

Conn., Winnipauk—Monks & Johnson, Engr., 78 Devonshire St., Boston, Mass., will receive bids about September 15 for the construction of a 6 story, 80 x 130 ft. factory off the State Road, for the Norwalk Tire & Rubber Co. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., Bronx—The Board of Education received bids for installing heating and ventilating apparatus in P. S. 57 Crotona and Belmont Ave., from E. Ruetzler Co., 404 East 49th St., New York City, $115,712; Gillis & Geoghagan, 537 West Broadway, $118,776; D. J. Rice, 405 Lexington Ave., $122,267; for installing temperature regulating apparatus in P. S. 57, from the National Regulator Co., 145 East 34th St., New York City, $5800; Johnson Service Co., 123 East 27th St., New York City, $6349; Powers Regulator Co., Park Ave. and 40th St., $7588.

N. Y., Brooklyn—Rockwood & Co., 88 Washington Ave., will build a 7 story, 50 x 100 ft. garage on Waverly and Park Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. G. A. Palcanis, Fanwood, N. J., Arch. Work will be done by day labor.

N. Y., New York—Buchman & Kahn, Arch. and Engr., 56 West 46th St., are preparing plans for a 16 story office building on 36th St. and 7th Ave. A steam heating system will be installed in same. Total estimated cost, $1,200,000. Owner's name withheld.

N. Y., New York—R. D. Kohn, Engr. and Arch., 56 West 45th St., will soon award the contract for altering 3 story, 50 x 75 ft. dormintory, and building two 3 story, 27 x 56 ft. and 41 x 152 ft. additions, on Havemeyer Ave., for the United Odd Fellows' Home. Steam heating systems will be installed in same. Total estimated cost, $125,000.

N. J., Freehold—The Board of Freeholders of Monmouth Co. is having plans prepared for a new heating and lighting plant, to include two 80 hp. boilers, and other equipment. Estimated cost, $25,000. C. A. Slocum, Long Branch, Arch.

Pa., Bethlehem—The Board of Education will receive bids September 16, for the construction of a 3 story, 180 x 250 ft. school, to be known as the South Side School. A fan system of heating will be installed in same. Total estimated cost, $300,000. V. T. Ritter, North American Bldg., Arch.

Pa., Philadelphia — Herman Miller, Arch., 1420 Chestnut St., is receiving bids for the construction of a 1 story, 36 x 80 ft. bank, at 23 East King St., for the People's National Bank, 7th and Girard St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Md., Baltimore—The Maryland Casualty Co., Baltimore and Fayette St., and Guilford Ave., plans to build business buildings and community settlement, on 40th and 37th Sts., Cedar and Elm Aves. Plans include separate building for mechanical and power plant. Initial cost $1,500,000. Total estimated cost, $3,000,000. J. T. Stone, Pres.

Md., Baltimore—The Rice Motors Co., Madison and North Ave., has had plans prepared for the construction of a 2 story, 140 x 250 ft. garage, on Whitelock and McCulloh St. A steam heating system, plumbing and electric lighting will be installed in same. Total estimated cost, $100,000. Smith & May, 1133 Calvert Bldg., Arch.

Md., Baltimore—The Thermopak Co., Omaha, Neb., plans to erect a plant here, for the manufacture of iceless and saltless ice cream refrigerators. Total estimated cost, $150,000.

Md., Jessups—The State Board of Prison Control, 701 Union Trust Bldg., Baltimore, plans to alter and build an addition to the Maryland House of Correction, here. Steam heating plant will also be extended. Total estimated cost, $150,000. R. D. Case, Secy. T. W. Pietsch, 1210 American Bldg., Baltimore, Arch.

S. C., Charleston—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until September 17, for the installation of a 2500 k.v.a. turbo alternator, here. Estimated cost, $50,000. Noted August 12.

Ohio, Cleveland—The Citizens Savings & Trust Co., East 9th St. Euclid Ave., is having plans prepared for an 11 story, 140 x 200 ft. bank. A steam heating system will be installed in same. Total estimated cost, $8,000,000. Graham, Anderson, Probst & White, Railway Exchange Bldg., Chicago, Ill., Engr.

Ohio, Cleveland—Osborn Engineering Co., Engr., 2848 Prospect Ave., is receiving bids for the construction of a 3 story, 100 x 200 ft. factory addition on Warner Road, for the Ideal Tire Co., East 17 and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The Pompeian Manufacturing Co., 2104 Superior Ave., is receiving bids for the construction of a 6 story, 75 x 150 ft. factory and office building, on East 24th and Payne Ave. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ohio, Cleveland—The F. B. Stearns Motor Car Co., Euclid Ave. and Lakeview, plans to build a 4 story, 200 x 400 ft. factory addition on Lakeview Rd. A steam heating system will be installed in same. Total estimated cost, $300,000.

Mich., Algonac—The village will soon award the contract for installing 3 horizontal, motor driven centrifugal pumping units, two for domestic use and one for fire service; domestic pumps to deliver 350 gallons per minute against total head of 100 ft.; fire service pump to deliver 1200 gallons per minute against total head of 200 ft. K. A. Haulter, Village Pres. Engineering Service Co., P. O. Box 364, Port Huron, Engr.

Ill., Chicago—The F. M. Barton Co., Arch., 1510 Kimball Bldg., is receiving bids for the construction of a 4 story, 60 x 100 ft. warehouse, on Kostner Ave. and Taylor St., for the Adams-Elting Co., 716 West Washington Bl. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ill., Chicago—The city is having plans prepared for the construction of a 1 story, 80 x 95 ft. engine room and transformer station, on Chicago Ave. near Michigan Ave. Total estimated cost, $300,000. C. W. Kallal, 1017 City Hall, Arch.

Minn., Duluth—The city is in the market for one gas operated air compressor. P. G. Phillips, commissioner.

Kan., Augusta—The city is having plans prepared for the construction of a 3 story, 44 x 120 ft. hospital. A steam heating system will be installed in same. Total estimated cost, $100,000. J. R. Switzer, Augusta, Arch.

Kan., Hutchinson—The State Exchange Bank, c/o F. W. Cooter, pres., is having plans prepared for the construction of a 6 story, 75 x 150 ft. bank. A steam heating system will be installed in same. Total estimated cost, $300,000. W. E. Hulse & Co., Hutchinson, Arch.

N. D., Fort Yates—Cato Sells, Commissioner of Indian Affairs, Washington, D. C., will receive bids September 18 for furnishing materials and labor for the installation of a sewerage system, service lines and an electric lighting plant, at the Standing Rock School here.

Mo., Kansas City—J. Ray Samuel, purchasing agt., City Hall, will receive bids until September 17, for designing, constructing, delivering and erecting in the Quindaro Pumping Station 1 steam driven pumping unit, of the capacity to pump continuously at the rate of 50,000,000 gallons of water per 24 hours. Bids will be received on 2 types of pumping units, i. e., the centrifugal type of pump driven by steam turbine through reduction gears and the centrifugal type of pump driven by a vertical cross compound Corliss engine. W. G. Goodwin, Ch. Engr.

Mo., St. Louis—The Bush-Sulzer Brothers Diesel Engine Co., 2nd and Utah St., is building new manufacturing plant and will be in the market for power equipment and other machinery. Estimated cost, $30,000.

Mo., St. Louis—Hugh & Co., 10th and Walnut St., is in the market for motors, generators, boilers, oil and steam engines. C. G. Hugh, Pres.

Mo., St. Louis—C. Smith, 4000 South Broadway, is in the market for boilers, tanks, engines and turret lathes.

Okla., Tishomingo—The town will receive bids until September 18 for the construction of a complete electric lighting plant and distributing system consisting of power house, two 75 k.v.a. generators direct-connected to semi-Diesel oil engine, etc. Johnson & Benham, Firestone Bldg., Kansas City, Mo., Consult. Engr. Noted Jan. 21.

N. M., Albuquerque—The Rio Grande Light & Power Co., Sturges Hotel Bldg., has had plans prepared for the construction of a hydro-electric power plant, 140 mile transmission line, an auxiliary steam plant and large dam in the White Rock canyon, 40 miles north of here, on the Rio Grande River. Total estimated cost, $4,300,000. A. G. Hillberg, Sturges Hotel Bldg., Engr.

N. M., Hanover—The Republic Mining & Milling Co. plans to construct a steam turbo generator power plant in connection with its zinc mine here. Is in the market for hoists, electrical equipment, etc. Total estimated cost, $100,000. O. Wiser, Supt.

Can., Toronto—The King Edward Hotel is having plans prepared for the construction of a 15 story addition to hotel. A steam heating system will be installed in same, Total estimated cost, $1,500,000. O. E. Goldschmidt, 116 West 39th St., New York City, Engr. Esenwein & Johnson, Ellicott Sq., Buffalo, N. Y., Arch.

Ont., Toronto—John M. Lyle, Arch., Avondale Rd., will soon receive bids for the construction of a 3 story, 80 x 150 ft. tannery, on Cameron Ave., for H. B. Johnstone & Son, 774 Dundas St., E. A steam heating system will be installed in same. Total estimated cost, $130,000.

CONTRACTS AWARDED

Vt., Bennington—The Bennington Hospital has awarded the contract for the construction of a 2 story nurses' home, to C. M. Cruikshank, 103 Park Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $100,000.

Conn., Rockfall—The Russell Manufacturing Co., South Farms, has awarded the contract for the construction of a 2 story, 20 x 20 ft. turbine building, 2 story, 15 x 22 ft. engine room and pump house and 1 story, 36 x 25 ft. boiler house, to Denis O'Brien & Sons, Inc., 118 Asylum St., Hartford. Total estimated cost, $15 000.

N. Y., New York—The R. S. Howard Piano Co., 485 East 133 St., has awarded the contract for the construction of a 3 story piano factory on East 133rd St., to the Ettinger Construction Co., 44 Court St., Brooklyn. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., New York—B. F. Keith, 1564 Broadway, has awarded the contract for the construction of a 3 story, 200 x 22[illegible] ft. theatre, on Fordham Rd and Valentine Ave., to the Fleischmann Construction Co., 531 7th Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. J., New Brunswick—The Hyjel Co., 40 Paterson St., has awarded the contract for the construction of a 2 story, 150 x 150 ft. theatre, to Fleischman Construction Co., 531 7th Ave., New York City. A steam heating system will be installed in same Total estimated cost, $250,000.

N. J., Trenton—The City Commission has awarded the contract for constructing 25,000,000 and 20,000,000 gal. electrical driven centrifugal pump, generator, motor, etc., in connection with pumping station, to Harry E. Stahl, 275 Bellevue Ave., $108,941. Noted July 22.

Pa., Erie—The School District has awarded the contract for heating and ventilating systems in proposed school building on Atkins and Brandes St., to Gannon & Carey Co., Erie, $48,000.

Mich., Manistique—Rome G. Brown, Metropolitan Life Bldg., Minneapolis, Minn., has awarded the contract for the construction of several paper mill buildings, to Siems, Helmers & Schaffner, foot of Market St., St. Paul, Minn. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ill., Moline—The Board of Education has awarded the contract for a steam heating system for proposed 1 story school, on 16th Ave. and 25th St., to the Moline Heating & Construction Co., 320 16th St. Estimated cost, $10,972.

Mont., Lewistown—Fergus County has awarded the contract for the installation of a steam heating system in the County High School, here, to E. J. Kane, Lewistown. Estimated cost, $27,598.

Mont., Scobey—The city awarded the contract for a 300 gallon per minute centrifugal pump, 40 hp. semi-Diesel engine and a waterworks system, to include 150 gallons per minute motor driven centrifugal pump, to G. W. Kemper, Minot, N. D. Total estimated cost, $96,269.

Mo., St. Louis—The Board of Public Service has awarded the contract for installing a steam heating system in the proposed 4 story, 54 x 125 ft. hospital, to the Peters-Eichler Heating Co., 1516 Pine St.; electrical work to the Guarantee Electric Co., 1305 Pine St. Estimated cost, $11,997 and $4864, respectively.

Mo., St. Louis—The Schultz Belting Co., 4th and Barton Sts., has awarded the contract for the construction of a 1 story, 40 x 70 ft. belt factory and power plant, to J. W. Cowper, Fidelity Bldg., Buffalo, N. Y. Total estimated cost, $15,000.

Mo., St. Louis—H. J. Wise, Engr., Post-Dispatch Bldg., has awarded the contract for the erection of a one story boiler house, etc., to William Voepel Co., 1113 Sidney St., for A. J. Feuerbacher, 1745 South 18th St., c/o Superior Laundry Co. Total estimated cost, $80,000. Noted Sept. 4.

Okla., Oklahoma—The city has awarded the contract for the installation of a fan blast air circulation heating and plumbing system in the Putnam Heights, Lowell, Hawthorne, Willard and Wheeler Schools, to Cook & McDonnel Co., 708 Herkovitz Bldg., $54,640.

A Personal Want—

can invariably be filled by a friend.

A Business Want—

must be satisfied by someone in your industry.

The Searchlight Section of this issue covers the current business wants of the machinery field

SEE PAGES 86 to 96

"Think* SEARCHLIGHT *First"

SEE PAGES 86 to 96